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Steel Castings for Our First Line of Defense

A Discussion of the Problems of the Naval Gun Factory With Description of Difficult Molding Jobs and Layout of Shop

By Lieut Walter S Doxsey

DEVELOPMENT along industrial lines during the last decade or so may be summarily characterized by universal and extensive expansion to keep pace with the ever-swelling demands of commerce, and by a thorough infusion of the principles of scientific management to combat the ever-increasing costs of raw materials and labor. A few industries have been able to apply and profit by shop efficiency systems through the erection of new plants; others which have increased their capacities by extending existing facilities occasionally have found that such additions worked to defeat the basic scheme of direct-routing products through the various departments. These later instances are by no means rare among foundries where existing melting and crane facilities cannot readily be shifted to suit ideal routing of work to conform with amplified floor space. The foundry at the naval gun factory, Washington, originally was 400 feet long, 131 feet wide and contained in addition to iron and steel equipment, a complete nonferrous foundry. The recent completion of a new building removes the nonferrous department from the foundry, making available approximately 5200 square feet of floor space for the production of steel castings. In addition to this, a 200-foot extension has been completed and is now being equipped. Previous to these changes, the steel foundry occupied the northern end of the building, the gray-iron plant the center section, and the nonferrous department the south end. While all the problems incident to expansion have not been completely solved, the probable layout of the enlarged foundry will be as given in Fig. 11. Sand for the steel molding floor is brought by railroad cars to the new sand storage building at the south end where it is distributed by an overhead conveyor into five bins. These bins open behind two 9-foot pan type sand mixers. In front of each mixer is a narrow pit about 3 feet deep which extends laterally into the main and side bays, respectively, so that a sand bucket on a car in the pit may be picked up by either the main bay crane or the crane in the side bay. Flasks are stored in a commodius yard adjacent to the dry-sand floor. A buggy track is arranged for carrying the flasks into the foundry, and incidentally, directly to the larger of the two molding machines. The rolled-steel flasks, uni-

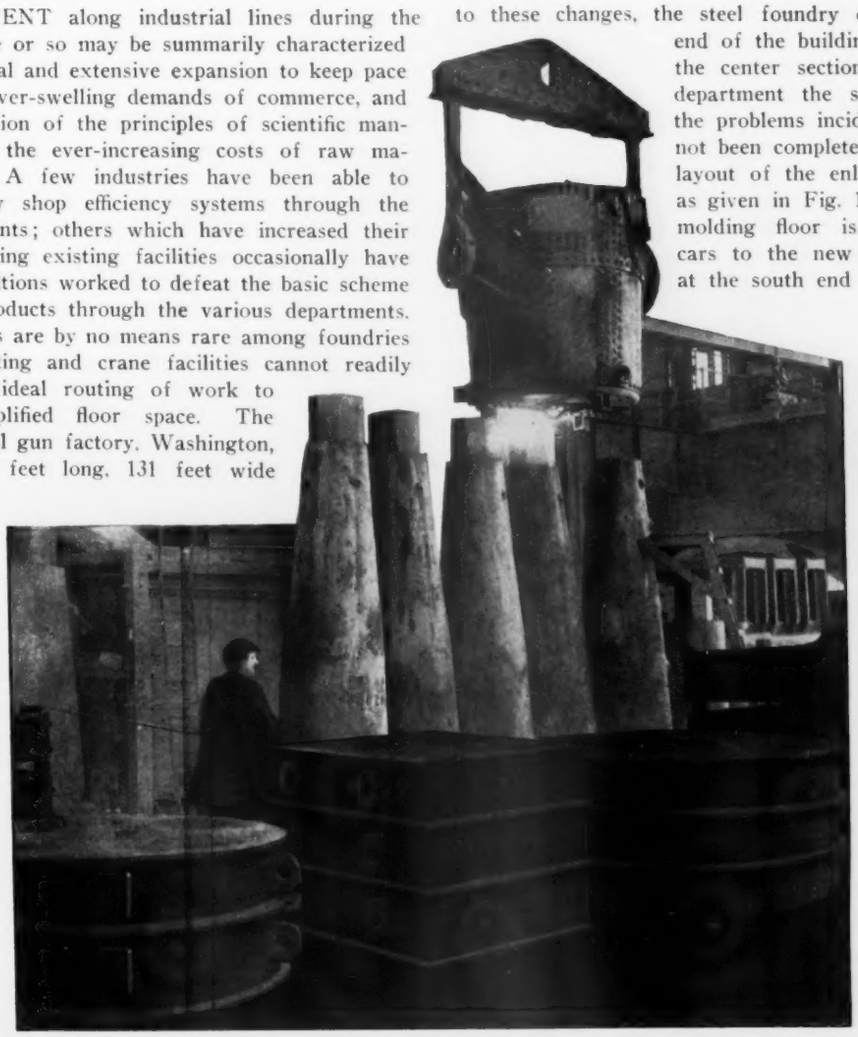
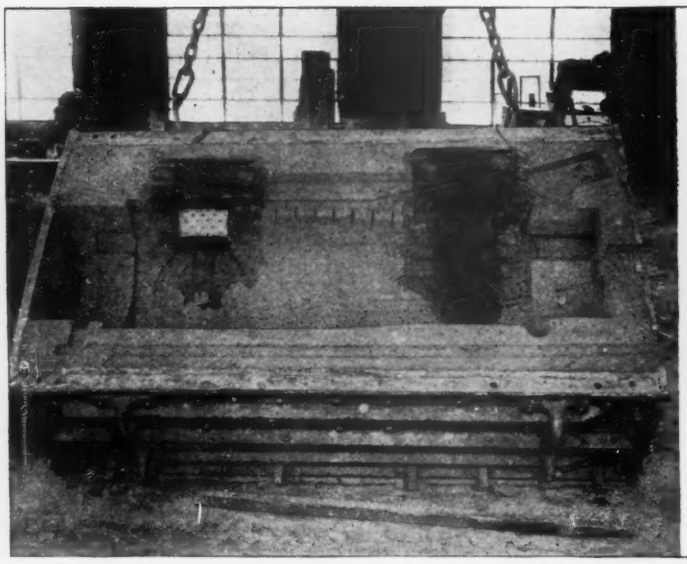


FIG. 1—POURING A HEAT OF STEEL INTO SPECIAL MOLDS AT THE FOUNDRY OF THE NAVAL GUN FACTORY AT WASHINGTON



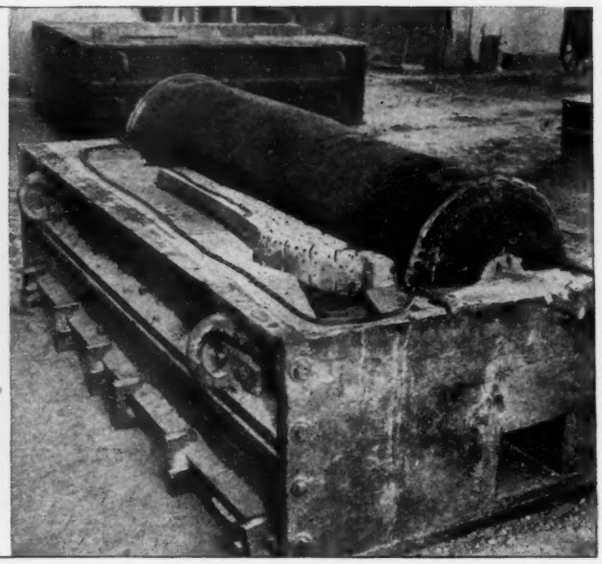


FIG. 2—VIEW OF PARTIALLY COMPLETED DRAG FOR 6-INCH GUN SLIDE FIG. 3—COMPLETED DRAG MOLD FOR 6-INCH GUN SLIDE SHOWING ALL CORES IN PLACE AND MOLD DAUBED READY TO RECEIVE COPE

versally used, are fabricated and repaired in a small but fully equipped shop on the north side of the flask-storage yard.

The steel output of the foundry is devoted entirely to the production of miscellaneous ordnance castings varying in weight from a few ounces to several thousand pounds. Variety is legionary and standardization of molding methods is impossible—at least in the sense understood by foundrymen accustomed to molding and casting several thousand pieces from the same pattern. The diversified production precludes the general use of automatic molding and coremaking equipment. Bids are now being considered, however, for the installation of two huge jar-ram, roll-over, pattern-drawing machines on the dry-sand floor. One of these will have an 84 x 120-inch table, a jolting capacity of 45,000 pounds, and a roll-over capacity of 20,000 pounds. The other machine is to be somewhat smaller, having a 64 x 72-inch table, a 10,000-pound jolting capacity, and roll-over capacity of 6000 pounds. These machines will be able to handle all the molds put up on the dry-sand floor and are expected to effect a considerable saving over the present method of hand-ramming with portable machines and rolling over with the aid of a crane. The new equipment will be placed as shown in Fig. 11. Medium size molds for steel castings are put up in the west bay, the large ones in the center bay, and small ones in the east bay which is equipped with 12 benches for snap molding. Dry sand iron molding is done in the main bay adjacent to the green-sand floor.

At the present time, cores are made in a small addition on the east side of the foundry building, not shown in the floor diagram. An improvement in coremaking facilities, however, is anticipated by devoting this addition to an issuing room for small foundry stores and by moving the core department to the east bay, just south of the drying ovens. Cores for green-sand molding will be made in a special department conveniently near that work.

The foundry is unusually replete with crane facilities. These, together with a well-arranged system of buggy

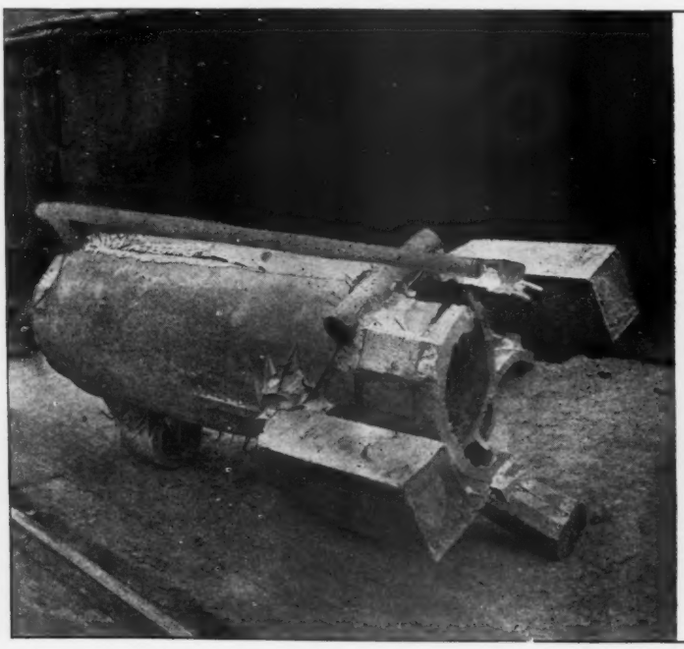


FIG. 4—THE GUN-SLIDE CASTING AS IT COMES FROM THE MOLD WITH GATES AND RISERS ATTACHED. FIG. 5—ANOTHER VIEW OF THE DRAG FOR GUN-SLIDE CASTING SHOWING USE OF NAILS FOR CHILLING

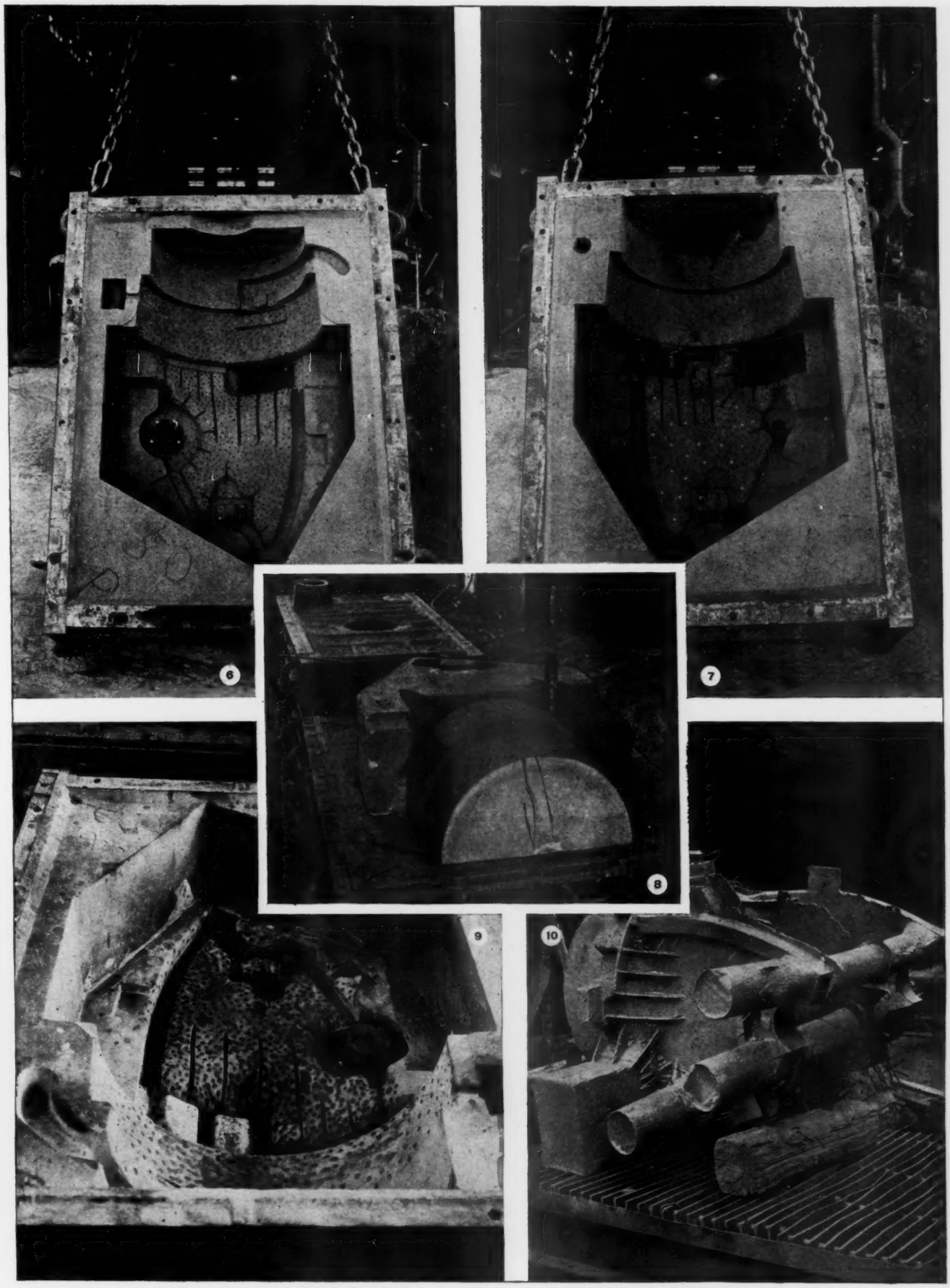


FIG. 6—DRAG HALF OF MOLD FOR A GUN CARRIAGE FOR 6-INCH GUN. FIG. 7—COPE HALF OF MOLD FOR GUN CARRIAGE
FIG. 8—DRAG HALF OF MOLD WITH CORES IN PLACE READY FOR CLOSING—NOTE POURING GATE TO THE RIGHT
FIG. 9—DETAILED VIEW OF DRAG MOLD FOR GUN CARRIAGE SHOWING LIBERAL USE OF NAILS
FIG. 10—FINISHED 6-INCH GUN CARRIAGE CASTING FOR BROADSIDE NAVAL MOUNT

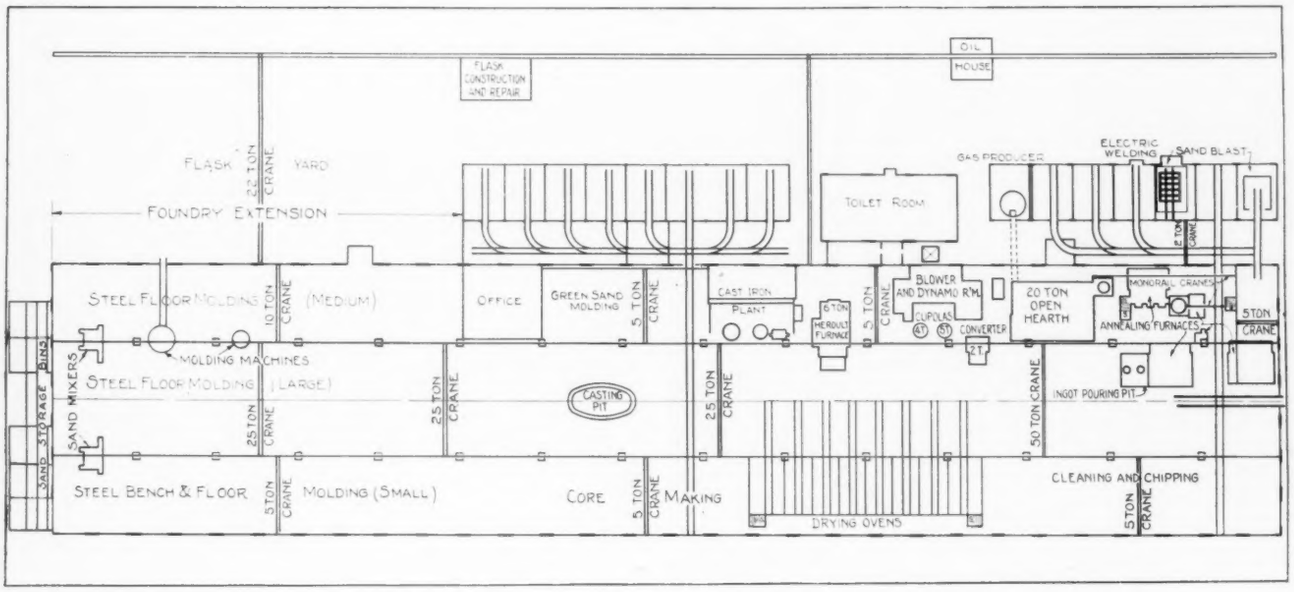


FIG. 11—GENERAL ARRANGEMENT OF FOUNDRY OF UNITED STATES NAVAL GUN FACTORY AT WASHINGTON.

tracks, reduce material handling problems to terms of utmost simplicity and ease. The arrangement of cranes is as follows:

Main Bay

Cranes No.	Cap'y, tons	Run	Builder
2	25	Full length of build'ng.....	Niles
1	50	Full length of building.....	Niles
1	25	Full length of building.....	Cleveland

East Bay

2	5	South end to drying ovens.....	Niles
1	5	Drying ovens to north end.....	Niles

West Bay

1	10	South end to office.....	Browning
1	5	Office to cast-iron plant.....	Niles
1	5	Above electric furnace.....	Morgan
1	2	(monorail) Above annealing furn.	Shephard
1	5	Above annealing furnace.....	.....
1	1	(monorail) Above annealing furn.	.....

Foundry Yard

1	22	Full length of yard.....	Shephard
1	15	Full length of yard.....	Niles
1	2	Gas producer to north end.....	.....

The steel for most purposes is made in a 20-ton open-hearth furnace designed by and erected under the supervision of engineers at the naval gun factory. This furnace, originally a 5-ton type, has been rebuilt successively to 10-ton and 20-ton size at the end of its normal life—the steelmaking capacity of the foundry thus keeping pace with demands for naval ordnance. A novel labor-saving feature adapted to this furnace is a pneumatic door opener consisting of an air cylinder whose plunger is connected to the door by means of a steel cable and pulleys. The cylinder is placed beneath the charging floor and is controlled by a conveniently located two-way valve as shown in Fig. 13.

Ordinarily the furnace is fired with crude oil, atomized with preheated air and fed through spray nozzles. For emergency use, a gas producer plant is available. This producer was installed by Wm. Swindell & Bros., Pittsburgh, and supplies suffi-

FIG. 12—ONE OF THE PRINCIPAL AISLES IN THE NAVAL GUN FACTORY FOUNDRY AT WASHINGTON

cient gas to operate the furnace at approximately 50 per cent of its rated capacity.

Auxiliary to the open-hearth furnace are a 4-ton and a 5-ton cupola, a 2-ton converter and a 6-ton Heroult electric furnace. In addition to this equipment, two cupolas of 10 and 15-ton capacities, respectively, are installed for producing cast iron. The cupolas are rated on an hourly basis as usual. The normal steel output varies from 40 to 50 tons daily.

After the molds have been poured, in the north end of the main bay, the flasks are picked up by a locomotive crane and carried to a sand pile just outside the foundry. When the sand and cores have been knocked from the castings, the castings and empty flasks are carried by the locomotive crane or pushed on a flat car to the north end of the foundry yard, the castings to be sand-blasted and the flasks to be transported by traveling crane to the flask yard. Equipment for sand blasting was installed by the Pangborn Corp., Hagerstown, Md., and by the J. W. Paxson Co., Philadelphia. The Paxson outfit is used for cleaning castings in the green and the Pangborn equipment for the final cleaning following annealing.

A buggy track extended across the foundry between the annealing furnaces serves to carry castings from the sand-blast room to the cleaning and chipping department. The same track conveys the work from this department to the annealing furnaces. Annealing is done in two large and two small oil-fired furnaces. After annealing, the castings are again sand-blasted, when they are ready for inspection.

Chemical tests of the metal of each heat are made immediately subsequent to pouring; physical tests from sample coupons are made as soon as the test pieces are cut from the castings after annealing. All castings are subjected to a minute surface inspection and to a knocking test with a 7½-pound hammer. Small surface cracks are filled with the aid of electric welding apparatus.

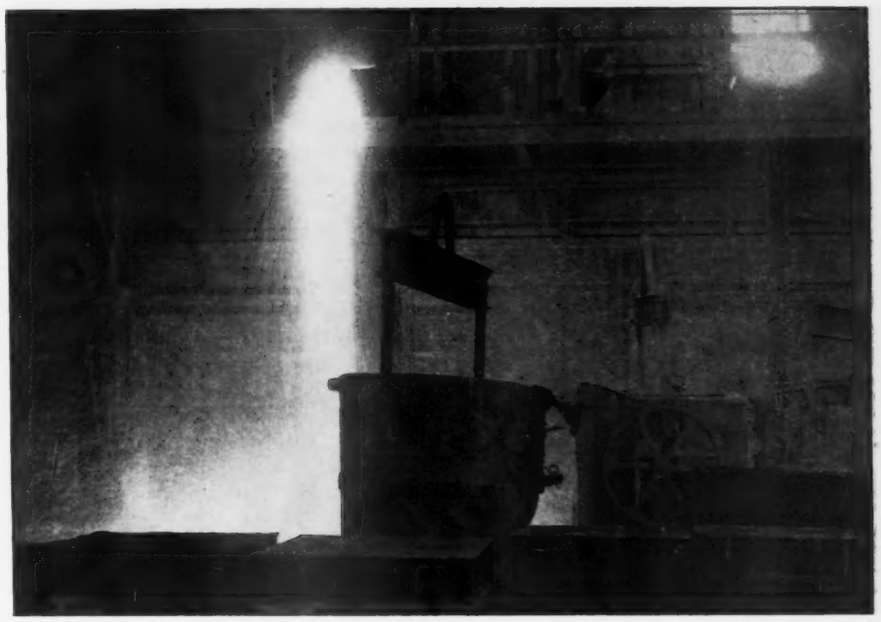


FIG. 14—TAPPING A HEAT OF STEEL FROM THE 20-TON OPEN-HEARTH FURNACE AT THE NAVAL GUN FACTORY FOUNDRY

Molding Methods

In normal times, practically all the ordnance castings necessary to equip and maintain the navy are produced in the naval gun factory foundry. Although the problems associated with the production of naval ordnance castings are now generally well known to foundrymen through war-emergency contracts, the methods adopted by this foundry in making large gun-mount castings are not wholly without an element of interest. Work is now in progress on 6-inch broadside mounts for some of the new ships now rapidly nearing completion. A broadside mount, exclusive of the gun, consists essentially of a stand, a carriage, and a slide; the carriage turns on the stand in a horizontal plane, and the slide moves in the carriage through a vertical arc. The unusual and severe loads imposed on a mount at the instant of firing, added to the dead-weight loading, call for complex steel castings which involve some rather interesting foundry problems.

The carriage is molded in a two-part steel flask, the drag and cope of which are each 5 feet 10 inches long, 4 feet 6 inches wide, and 2 feet 6 inches deep, inside dimensions. Due to the relatively small number of castings made from any one pattern, wood patterns are generally used in the naval gun factory foundry, except on torpedo and similar work where accuracy is a paramount consideration. The carriage pattern is made of pine and is split vertically, parallel to the side plates or trunnion arms. In molding, the pattern is placed on a pattern board, covered with facing sand, and rammed solidly with heap sand. A mixture of three wheelbarrows of silica sand, one wheelbarrow of finely crushed rock, and one wheelbarrow of clay mixed and ground together with a binder of molasses water is used for facing sand. Four bars and numerous gaggers are placed in the cope; the drag has neither bars nor gaggers.

Disastrous and unsatisfactory results in casting these carriages are largely avoided by the liberal use

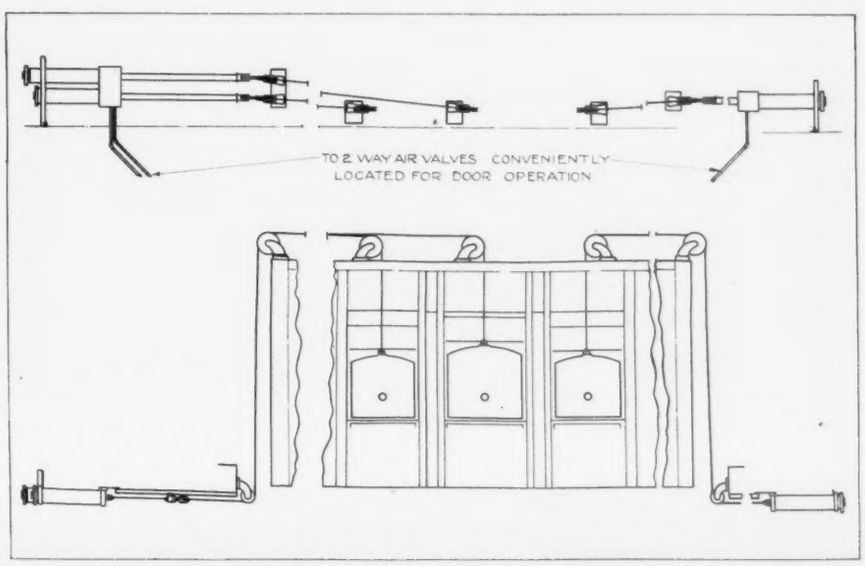


FIG. 13—DIAGRAMMATIC SKETCH SHOWING OPENING GEAR FOR OPEN-HEARTH FURNACE DOORS

of nails which serve the purpose of chill plates to dissipate the cooling strains occurring at junctions of thin and heavy sections, as well as to support the sand in the mold. This feature is illustrated in Fig. 9 which shows how the nails are placed in the heavy section at the trunnion. Approximately one full keg of nails is used in preparing the mold for a single carriage.

Another factor which has contributed largely to the success of this foundry in producing steel castings for ordnance purposes is the use of unusually large shrink heads. Fig. 10 shows the location and size of the gate and heads, and Figs. 6 and 7 illustrate the method of cutting them in the drag and the cope respectively. The heads and gate weigh 1050 pounds or about 35 per cent of the casting itself. The casting is gated on the pivot bearing end. The steel is poured into the mold through a double-gate consisting of two 1 x 4-inch sprues spaced about 4 inches apart, shown in Fig. 3. The large rectangular head, approximately 12 x 16 inches in section, rises 13 inches from a flat surface on the side of the carriage just above the pivot bearing. The two round shrink heads are 6 inches in diameter and are continued through the cope to the drag. The third round head is also 6 inches in diameter, but does not extend through to the drag.

Before baking, a mold wash of silica flour, salt and molasses water is used. The molds are baked for 12 hours in an oil-fired drying oven after which the cores are placed and the mold is closed ready for pouring. With the exception of two small cores placed in the drag before baking, the three large cores shown in the dried mold, Fig. 8, are each provided with a 1-inch crushed-cinder vent to permit egress of the hot gases. One of the vents, clearly visible in Fig. 8, extends through the cope to the top of the flask; the other two exhaust between the drag and cope. Two molders turn out a finished mold in two days of eight hours. This is exclusive of the time required to make the cores. Upon the installation of the jar-ram, roll-over, and pattern-drawing machines, it is expected that the time of molding these carriages will be materially reduced.

Although the 6-inch slide is molded similarly to the carriage, a few of the differentiating features involved make it an interesting foundry problem. The size of the slide casting is indicated by the dimensions of the closed flask which is 8 feet 6 inches and 4 x 5 feet in section. The long cylindrical shape of the slide and the similarity of the drag and cope cause the mold to lend itself readily to top pouring. Fig. 2 showing a partially completed drag on the molding floor, illustrates the method of gating and shows some of the small cores in place. Here again nails are liberally used as shown in Fig. 2, and better in Fig. 5. All the cores, except the large barrel core, are placed in the drag before baking. The baked drag with all the cores in place is shown in Fig. 3. A vent from the barrel core may be seen projecting from the right. Chill plates designed to relieve cooling strains where the heavy trunnion bosses and recoil cylinder brackets join the slide cylinder are clearly shown in Fig. 5.

The size of the heads and their relative proportions as compared with the slide itself may be judged by referring to Fig. 11. In addition to the two large rectangular heads, which are about 12 x 20 inches in section, additional shrink heads of smaller dimensions are cut, one in the cope, one in the drag and one between the two parts of the mold. The total weight of the slide is 3750 pounds while the heads and gates alone weigh 1300 pounds.

The carriage and slide castings are annealed in an oil-fired furnace. They are brought to a temperature of 1800 degrees Fahr. during a period of 18 hours, held at this temperature for 12 hours, and allowed to cool slowly.

In view of the present-day quantity production of sound steel castings for our first line defense, it is interesting, in retrospect, to glance through the history of the naval gun factory where we read that "The first effort to make steel castings in the yard was made by an employe of the east gun carriage shop somewhere around 1894 or 1895." This man submitted plans for a furnace which were approved, and a small furnace in accordance with his ideas was erected in the east end of the old foundry building. He was allowed to experiment with this for several months, making a number of small castings. These castings were of a very poor grade of steel, and as he was unable to improve on the quality the effort was finally given up and the furnace removed.

Inclusions in Steel

At the annual meeting of the American Iron and Steel institute in New York, May 23, a paper discussing nonmetallic impurities in steel was read by Henry D. Hibbard, consulting engineer, Plainfield, N. J.

Special attention is paid to those nonmetallic impurities which are insoluble in molten steel and which are often called oxidation products, enclosures or inclusions but which the author terms sonims.

Such impurities when found in steel are divided into five classes:

1.—The products from the reactions of the manganese and other additions with the sulphides and oxides of the unfinished steel.

2.—The products from the oxidation of some of the finished steel ingredients by atmospheric oxygen during the progress of the steel from the furnace to solidification in the molds.

3.—Oxides from the unfinished steel.

4.—Slag particles entrained particularly from the intimate mixing which results from pouring the charge into the ladle.

5.—Particles of dirt and other nonmetallic matter such as bricks and clay with which the metal comes in contact during its passage from the furnace to the molds and which are too small for gravitation to send to the top.

The occurrence and cause of sonims in bessemer, open-hearth and electric furnace steel are considered and remedies are suggested. The effect of holding the steel in the ladle before pouring was found to be beneficial.

In dealing with the effect of sonims on steel it is pointed out that the way in which such substances are distributed within the metal is even more important than their quantity. If collected in globules they are most injurious. Their tendency is to make the steel red short, especially in the unfinished state.

Specifications in Spanish

The bureau of foreign and domestic commerce, department of commerce, Washington, is issuing a series of pamphlets containing copies of the standard specifications of the American Society for Testing Materials, translated into Spanish. The English originals are given in each case on facing pages. These pamphlets are distributed by the bureau of foreign and domestic commerce at a nominal price. Recently specifications for the following materials have been translated: Malleable-iron castings, cast-iron car wheels, cast-iron locomotive cylinders, structural steel for cars, carbon-steel car and tender axles, iron and steel chain, and extra-high-carbon steel splice bars.

The McDougall-Duluth Co., Duluth, Minn., is contemplating the erection of a steel foundry to make castings up to 500 pounds in weight. This plant is intended to be supplementary to the company's shipyard in Duluth.

Influence of Lime on Acid Open-Hearth Slags

Samples of Slag Should be Taken in Order to Get Information to Enable the Melter to Maintain a Proper Equilibrium

By B Yaneske

THERE recently has been a great deal of controversy between steelmakers relating to the value of limestone in the working of a charge in the acid open-hearth furnace. At some steelworks it is the usual practice for the melters to add considerable quantities of limestone to the bath during the oreing period, while at other works limestone is seldom used owing to the view that it is not essential, or that it has an injurious effect on the quality of the steel. It is the author's experience that insufficient attention is paid by some steelmakers to the condition of the slag during the working of a charge. Their object being to make steel and not slag, the composition of the latter does not interest them, and they entirely overlook the fact that the quality of the steel depends upon the state of the slag.

The author's object in submitting this paper is to illustrate the utility of taking slag samples in conjunction with metal samples; to explain the effect which the addition of limestone has on the slag and metal; and to point out how valuable limestone can be, if used judiciously, in obtaining perfect equilibrium in the furnace bath, which can only occur when the metal has become thoroughly deoxidized, the attainment of this condition being essential before the addition of the finishing alloys if the subsequent production of steel of the highest quality is desired. To explain how such a condition may be consistently acquired, it is necessary to describe the manner of working a charge, which the author has found to be ideal for the end in view.

Appearance of the Slag

Taking as an example the working of a 0.50 per cent carbon steel heat, the charge consisting of 50 per cent low-phosphorus pig iron (4 per cent carbon, 2 per cent silicon) and 50 per cent scrap, the first point to be observed is the necessity of melting down very hot, which reduces the basicity of the slag formed by oxidation, etc., during the melting period, the proportion of silica to basic oxides composing the slag being a function of the temperature. When the charge is clear-melted, the addition of iron ore should never be commenced until the melter is certain that the bath is sufficiently hot. Optical pyrometers are very useful for controlling furnace bath temperatures, and the premature addition of iron ore can be prevented if a satisfactory pyrometrical reading of the surface of the bath is obtained (while the gas is absent during the reversing period), before the addition of the iron ore is commenced.

If at this stage a sample of slag be taken in a small test-spoon and the fracture examined, whether the sample has been quenched in water or allowed to cool in the air, it will be found to be black or bronze in color, with a metallic appearance due to the high percentage of oxides of iron and manganese present, and the composition will be approximately—SiO_2 48 per cent, MnO 16 per cent (depending upon the percentage of Mn in the charge), and FeO 33 per cent. The basicity of the slag depends upon the proportion of the total basic oxides to the acid silica, but as the percentage of manganese oxide, once established, usually only changes by steadily decreasing as the volume of slag is necessarily increased by the additions of iron ore, it is therefore the proportion of iron oxide to silica (both of which are variable to a considerable extent according to the working of the charge), to which attention is chiefly directed.

Iron Ore Additions

When the temperature after melting is quite satisfactory, additions of iron ore can be made at a fairly rapid rate without risk of cutting the furnace hearth. The primary object being to obtain a high quality of steel as expeditiously as possible, the bath is quickly brought to the boil by continuous ore additions. It is essential that a highly siliceous slag be formed during the oreing period, and this can only be achieved by maintaining the bath at a high temperature throughout the whole operation. After the boil has been obtained, samples of slag are taken and fractured at intervals between periods of steady ore additions, and it is observed that as the silica increases and iron oxide consequently decreases in the slag, the fractures become lighter in color. The steadily increasing acidity of the slag can also be discerned by the appearance of the boil in the furnace, for the slag becomes more and more viscous, whereas it is thin and mobile when the slag contains a high percentage of iron oxide.

Spoon samples of metal are also taken periodically, and if a reasonable amount of *stewing* has been allowed after each ore addition, with the bath kept consistently at as high a temperature as the refractories of the furnace will allow, the samples will become more or less riddled with holes, and the slag covering the metal is seen to rise in the spoon owing to the escape of gas. This is a true indication that a stage has been reached when the slag has become so highly siliceous that there is an excess of silica above that required to satisfy the reduced amount of basic oxides present. Consequently this excess silica once free from combination with the basic oxides, begins to be reduced by the iron, the silicon passing into the metal, and the oxygen

Slag Study Important

The metallurgist is primarily interested in the theory of steel melting and the reactions which take place during the heat, while the open-hearth superintendent and the melter are prone to be too well satisfied with what they learn from the practical experience without delving into reasons why and basic causes covering what goes on in the furnace.

In Mr. Yaneske's article the importance of studying the action of different slags is pointed out and the reactions of the slag with the metal under varying conditions are elucidated in a manner which will be understood by the melter as well as by the metallurgist. This is appreciated because it is becoming more clearly realized among foundrymen that the theory of steelmaking is important to the practical man as well as to the technical man and that both of these men need more of what the other has.

A paper presented at a meeting of the British Iron and Steel Institute held in London in May, 1919.

liberated from the silica perforating the metal samples, thus:

$$SiO_2 + Fe = FeSi + O_2$$

In the furnace bath, where the slag is only in contact with the surface of the molten metal, the oxygen will escape from the silica reduced without passing through the metal.

The author here ventures to disagree with several authorities who have stated that it is the carbon which effects the reduction of the silica according to the equation:

$$SiO_2 + 2C = Si + 2CO$$

Iron is Reducing Agent

It is the author's opinion that iron must be a far more powerful reducing agent than carbon, for iron is always present in great excess, and it is an established fact that oxygen has a greater affinity for silicon than for carbon in the open-hearth furnace, this being the basis of the acid process, therefore it seems highly improbable that carbon will displace oxygen from combination with silicon at the furnace temperature. For carbon to reduce silica according to the preceding equation, it is easily calculated that there must be a loss of 0.06 per cent carbon from the metal for each gain of 0.07 per cent silicon from the slag, and yet analyses have proved to the author that the reduction of silica has frequently occurred to such an extent that the percentage of silicon passed into the metal from the slag has exceeded 0.10 per cent while the carbon in the bath has not fallen more than 0.03 per cent. In fact, he has always found the loss of carbon to have been less than normal whenever there has been a considerable gain of silicon from the slag, for whatever be the true reaction it is obvious that for silica to be reduced at all, the amount of oxygen dissolved in the metal must have reached a minimum; therefore it can only be by atmospheric oxidation effected by the action of the furnace gases that the carbon is removed when the metal is free from dissolved iron oxide. Iron in the absence of dissolved oxygen is also liable to reduce some of the silica of the hearth, particularly when the hearth has been newly sanded, the silicon passed into the metal being again oxidized by the subsequent addition of iron ore, thus causing an increase in the silica content of the slag.

When, and not until, the reduction of silica occurs as indicated by the holes in the metal samples, limestone is carefully added with the next ore addition. The addition of limestone at this stage prevents the reduction of silica from the slag, as the calcium provides a new base for the excess silica, the two compounds forming a lime silicate in the slag. The iron ore directly attacks the carbon, whereas if the lime addition is omitted, so much of the oxide of iron will be required to oxidize the silicon passed into the metal, and to provide a base for the excess silica in the slag. After the addition of sufficient limestone, the holes soon disappear from the metal samples, and the melter is enabled to obtain a sound sample, by the fracture of which he can more easily judge the carbon content of the metal. The addition of limestone also increases the fluidity of the slag, which would otherwise become too viscous with such a high silica content.

Each time that holes occur in the metal samples a little more limestone is added with the next ore addition, and the addition of ore can be fairly rapid whenever the holes appear in the samples, so long as the carbon in the metal is well above that at which it is desired to tap the furnace. The practice of some melters is to lower the temperature of the bath by turning off some of the gas for a short time whenever the samples become riddled with holes, or the slag becomes too viscous owing to a high silica content. The reduced temperature of the bath facilitates the oxidation of iron from the metal, thus effecting an increase of iron oxide in the slag. This procedure, however, is very unsatisfactory, as it is not always possible for a melter to control the temperature of his furnace bath to such a fine point that just sufficient iron oxide is taken up by the slag to combine with the excess silica and the lowering of the temperature may easily be overdone to such an extent that the slag becomes highly basic with iron oxide with its consequent undesirable results, whereas a melter can judge very accurately by practice how much limestone is required to *clear* his samples. The practice of varying the temperature also greatly endangers the life of the furnace.

Temperature of Bath

The addition of cold scrap to the bath will also prevent the reduction of silica by lowering the temperature of the bath. Rogers has referred to the use of scrap for obtaining a properly dead-melted condition when the metal has become over-oxidized by excessive temperature. The present author has never known the metal to become wild owing to the application of too much heat, and it is his opinion that most probably the samples *lifted* in the spoon owing to the reduction of silica, this being mistaken for wildness. The addition of scrap, by chilling the bath, has caused the reaction to cease.

After the addition of limestone has been commenced, the presence of lime can be discerned in the slag samples, the fractures showing a green coloration. This green color is more pronounced in a slag which has been quenched in water than in one which has been allowed to cool in the air. As more and more limestone is added, the quenched slag assumes a light green color, corresponding to a light grayish-green color in the air-cooled sample. When these colorations have been obtained, the addition of limestone is discontinued and only iron ore added, for the presence of too much lime would prevent any further reduction of silica from the slag, required at the end of the process. When it is judged by the fracture of the metal samples, or by carbon determinations, that the carbon content of the metal is nearing the percentage at which the finishing additions are to be made, the addition of iron ore is discontinued, and the bath is allowed to *stew* until the appearance of holes in the metal samples again shows that silica is being reduced from the slag at a little above the desired carbon percentage, when a final addition of limestone is cautiously made. Only just sufficient is added to provide the lime necessary to combine with the excess silica, the limestone being added a little at a time until perfect equilibrium between the slag and the metal is obtained.

Obtaining Equilibrium

The fracture of the quenched slag at the end of the process should be of a light green color, with a subvitreous luster, while the fracture of the air-cooled slag should be light grayish-green, with light green edges where the slag has cooled more rapidly than the interior, the air-cooled slag possessing a very tough stony texture.

For equilibrium to be obtained it is essential that the metal be thoroughly deoxidized, and all reaction between the slag and metal must cease. This condition is only indicated by the appearance of the metal samples, which show clearly the degree of deoxidation of the metal, for the slightest reaction occurring can be easily discerned by an examination of the upper surface of the samples, when no reaction is apparent in the test-spoon. When true equilibrium, or in other words, an absolutely dead-melted condition of the bath, is acquired, the metal samples will be found to be perfectly sound in every detail, the limit of deoxidation of the metal having been reached when it is observed that the skin of the sample

shows rippled marks on the upper surface, caused by the surface tension of the liquid metal. C. Johns was the first to point out that this surface tension phenomenon is the most valuable indicator of the purity of the molten metal, for, as in other liquids, the degree of the surface tension is decreased by the presence of certain impurities, so these surface tension ripples never occur when any appreciable amount of iron oxide remains dissolved in the metal.

Gas from Reduced Silica

Although the metal must be in a highly deoxidized condition before equilibrium can be attained, yet it often occurs that while the metal is thoroughly deoxidized, equilibrium of the bath does not occur owing to the reduction of silica from the slag. Thus metal samples will be obtained showing surface tension ripples on the upper surface, and having deep holes in the under surface due to the pressure of the oxygen escaping from the silica upon reduction. The addition of a little limestone to the bath will soon cause the holes to disappear from the samples, and as soon as the samples become quite sound, while the skin of the upper surface is rippled, a perfectly dead-melted condition of the bath is obtained. Different stages of oxidation are clearly indicated on the upper surface of the metal samples. The nearest approach to the ideal sample showing surface tension ripples is one which is quite smooth on the upper surface. Then follows the sample which is slightly sunken, and shows signs of dendritic crystallization due to a slight reaction taking place in the test-spoon. This class of sample is obtained when there is a little iron oxide present in the metal owing to slightly excessive limestone or ore additions. There are various qualities of samples below this category, but the examples given serve to illustrate the author's meaning.

By the foregoing procedure it is possible to obtain a perfectly dead-melted condition at any carbon content of the bath. As the attainment of equilibrium can only be temporary, as soon as this condition is obtained and the percentage of carbon in the bath is satisfactory, the usual finishing additions should therefore be made to the bath during the final carbon determination, and the furnace quickly tapped, and any further manganese, silicon, or anthracite coal additions made to the ladle after tapping.

A good casting temperature is insured by this method, for the steel is always hot enough to cast if the bath is hot enough to cause the reduction of silica from the slag, whereas it is possible to obtain sound samples by killing an oxidized bath with additions of silicon or manganese, or both, even though the steel be too *cold* to cast.

The additions of limestone during the early stages of the operation as described, are only necessary when a good quality of hematite iron ore is used containing less than 1.5 per cent of lime and magnesia, which acts similarly to lime. If an iron ore be used which contains a high percentage of lime, such as some qualities of Spanish ores, the lime of which may average over 6 per cent, the slag fractures very soon become green, as the ore itself adds sufficient lime to yield a green coloration. When it is seen that the slag is becoming light green with only ore additions, limestone should only be added at the end of the operation when holes appear in the metal samples after the final *stewing* of the bath.

When making nickel-chrome steels, nickel-chrome scrap having been charged, the same procedure as described for carbon steels is followed, but darker-colored slags are obtained owing to the presence of chromium oxide in the slag.

The addition of lime in excess is sometimes due to the fact that too much faith is placed in the physico-chemical law which states that with a constant temperature the ratio of the concentration of iron oxide in the metal to the iron oxide in the slag is constant, and that therefore the lower the percentage of iron oxide in the slag, the lower the percentage of iron oxide in the metal. Limestone is therefore added in considerable quantities during the working of a charge with the object of steadily decreasing the concentration of iron oxide in the slag, so that by the end of the process the slag will contain a very low percentage of iron oxide, and a correspondingly low concentration of iron oxide in the metal is expected.

Oxides in the Slag

The addition of any lime beyond that which may be required to satisfy any excess silica of the slag as previously described in the paper, results in the displacement of some iron oxide from the slag. The slag consists of a solution of (R)O silicates, the silica being divided between the bases according to the proportion in which they occur in the slag. The further addition of the base lime combines with its equivalent of silica, which has a greater affinity for lime than for iron oxide, due to the fact that the iron of the metal possesses a great tendency to dissolve its own oxide, whereas it is only possible for lime to be dissolved into the slag. The iron oxide expelled from the slag passes into the metal, and equilibrium is not attained until this iron oxide is reduced by the carbon of the metal, thus:

$$(2FeO,\ SiO_2) + CaO = (CaO,\ SiO_2) + 2FeO$$

$$FeO + C = Fe + CO$$

While then, it is preferable to replace some of the iron oxide by lime, this should only be carried out to the extent of equilibrium being restored by the carbon of the metal reducing all the iron oxide displaced from the slag, before the percentage of carbon is reached at which it is desired to tap the furnace. If, therefore, a melter adds a little excess limestone beyond that required to clear his metal samples of holes during the early stages of the process, no harm ensues while the carbon in the bath is well up, but at the end of the process great care should be exercised that the limestone addition required is not exceeded.

When the metal samples at the end of the operation show the presence of a little dissolved iron oxide due either to slightly excessive limestone or ore additions, sound samples can soon be obtained if a little siliceous pig iron be allowed to melt on the banks of the hearth and run into the slag, but it is always preferable to avoid the necessity for this adjustment.

Too Much Lime

If limestone be incautiously added during the working of a charge, the slag may contain such a high percentage of lime that it is very difficult, and sometimes impossible, to get it into such a condition that silica begins to be reduced, even after lengthy *stewing* of the bath, for the occurrence of this reaction is prevented, first, by the displacement of iron oxide from the slag into the metal, and secondly, by the demand of the excessive amount of lime present for silica which it will obtain by attacking the furnace hearth at the slag level.

The presence of a high percentage of lime in the slag can always be discerned by an examination of the slag fractures. At the end of the process described by the author, the slag obtained is light green with a sub-vitreous luster for the quenched sample, and light grayish-green with a stony texture for the air-cooled sample, the percentage of lime and magnesia in the slag being about 5 per cent. When the percentage of these bases is in the proximity of 7 to 10 per cent and the silica 55 to 58 per cent, both the quenched and air-cooled slag samples assume a bottle-green color with a more vitreous luster, and a slag containing about 10 per cent lime and 55 per cent silica possesses the property of being drawn out, while molten, into threads like glass wool. Threads of such slag have been ob-

served by the author to stretch from the furnace to the water-bosh, a distance of several feet, slag adhering to the test-spoon having been drawn out as the sampler has carried the spoon away from the furnace. Whenever it is observed that the air-cooled slag sample is green as well as the quenched sample, difficulty is usually experienced in obtaining the reduction of silica from the slag as desired by the author at the end of the process.

Effect of Excess Lime

Many cases are known to the author where such large amounts of limestone have been added to the bath that, in addition to the lime having seriously damaged the furnace banks, the iron oxide expelled from the slag has not nearly been reduced by the carbon of the bath, even after many hours *stewing* down to about 0.10 per cent carbon without ore additions. In such cases, when samples of metal are taken from the bath, the slag in the spoon is seen to rise owing to the escape of carbon monoxide from the metal, leaving a space between the slag and the upper surface of the metal, and the metal samples are badly *nibbled* round the sides and on the upper surface owing to the energetic reaction between the dissolved iron oxide and the carbon in the metal. These marks are easily distinguishable from the holes caused by the reduction of silica which always appear on the under surface of the sample first.

It may happen that the presence of such an excess of lime in the slag is not entirely due to the addition of limestone, but to the use of an iron ore containing a very high percentage of lime, such as 10 per cent or over, or to the addition of basic slag in error which sometimes occurs in plants where both basic and acid furnaces are in operation.

If the bath be *stewed* for lengthy periods when there is an excessive amount of lime present in the slag, it is possible to obtain a slag very high in silica and low in iron oxide which according to some steelmakers is all that is desired, and yet the metal samples will be very poor, being badly *nibbled*. When a sample of such slag containing both high percentages of lime and silica, that is 10 per cent lime and 62 per cent silica, is taken and fractured, whether it has been air-cooled or quenched in water, it will be found to be very brittle, and to have a brown or yellow color, with a vitreous luster, in contrast with the bottle-green color obtained with such a high percentage of lime but a lower percentage of silica, the fractured surface of the slag always being very shiny when there is a high percentage of lime and magnesia in the slag, and the luster of the quenched slags is of a higher degree of intensity than the luster of the air-cooled slags.

Contrary to the statements of some writers that the continued addition of limestone consistently causes the slag to become more and more mobile, this is only true when the silica content of the slag does not exceed 58 per cent, for if 60 per cent or more silica be present, a stage appears to have been reached when the slag loses its mobility no matter how much lime is added. Kilby has alluded to slags containing 60 to 62 per cent silica and about 10 per cent lime as being in a fairly mobile condition, but it is the present author's experience that when a slag of such composition is obtained it is not at all mobile, but has a very pasty appearance in the furnace, and it is very difficult to establish equilibrium in the bath so as to obtain sound metal samples.

The following is an analysis of a very siliceous slag containing a high percentage of lime in the presence of which considerable difficulty was experienced in obtaining satisfactory metal samples:

	Per cent
SiO_2	61.40
FeO	19.00
MnO	7.00
CaO	9.30
MgO	0.86
Cr_2O_3	1.14
Al_2O_3	1.00

This slag was very pasty in the furnace, and the fracture was brownish-yellow, with a vitreous luster. The metal samples were very badly *nibbled* and the melter had unsuccessfully attempted to get rid of the marks on his samples by allowing the bath to *stew* for a lengthy period without ore, the carbon in the bath being about 0.15 per cent when the slag sample was taken for analysis. Good samples were eventually obtained by recarburizing the bath with pig iron, but this of course occasioned a great loss of time, and the casting temperature of the steel was below normal owing to the very pasty nature of the slag.

Making Slag Fluid

In another instance when a pasty slag of similar composition was obtained, causing defective metal samples, instead of allowing the bath to *stew* down, good hematite iron ore was added in excess for the purpose of increasing the percentage of iron oxide in the slag by oxidation of the iron of the bath, causing loss of iron from the metal, thus increasing the volume of slag and therefore decreasing the percentage of silica and lime in the slag. This was found to be a much better method of dealing with such a slag, for by this procedure it became very fluid. The metal was then recarburized with sufficient pig iron to reduce the excess of iron oxide in the metal, while the slag was sufficiently fluid after recarburization to prevent any difficulty in obtaining the steel hot enough to insure a good casting temperature. The following are analyses of the slag before and after the addition of excess iron ore, the carbon in the bath being about 0.65 per cent and 0.08 per cent, respectively when the slag samples were taken:

	Pasty slag. Per cent	Fluid Slag. Per cent
SiO_2	62.2	56.6
FeO	16.1	23.8
MnO	8.2	7.4
CaO	10.7	9.75

When adding limestone it should always be remembered that once lime is established in the slag it cannot be removed, and when this base is present in excess it is only by increasing the volume of the slag that the percentage can be reduced. This can be effected by the addition of a considerable quantity of a good quality of acid slag containing a low percentage of lime, but this procedure would cause the charge to become practically unworkable owing to the large volume of slag which would result.

Deoxidizers Sometimes Beneficial

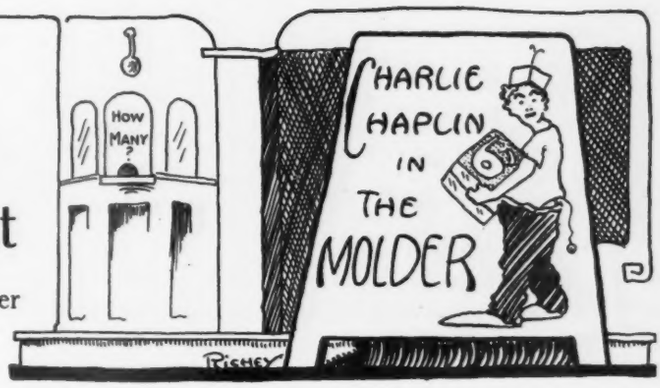
When the samples are defective owing to excessive lime additions, sound samples can be temporarily obtained by *dosing* the bath with such deoxidizers as ferrosilicon or silico-manganese. This expedient may give satisfactory results for some classes of steel, but the finished steel would most probably contain an appreciable amount of insoluble silicates as a result, which nonmetallic impurities are very undesirable in steels required for special purposes. If the purpose for which the steel is required will allow such additions to be made, the furnace should be tapped as soon as possible after the samples are satisfactory, before the slag has time to react, and any other additions of silicon and manganese required should be added to the ladle. Otherwise, it will not be long before the reaction of the slag causes the samples to become almost as bad as they were before the additions were made.

Whenever it is observed that the slag is very thin, *i. e.*, highly basic with iron oxide, owing to the furnace having been maintained at too low a temperature during melting or while oreing, it is foolish for a workman to add any limestone to the bath. When such a slag is obtained it will usually tax a melter's skill and patience to get rid of the great excess of dissolved iron oxide from the metal so as to get the bath into proper condition or equilib-

(*Concluded on page* 384)

Bill and The Pattern-maker Dope It Out

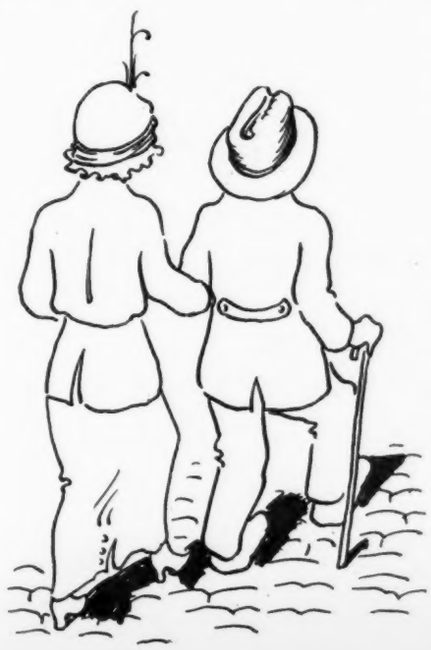
By Pat Dwyer



ONCE in a while, when our universal and mutual friend, Charlie Chaplin, comes to town, my dear and only wife loosens up the family purse strings and proposes that we forget dull care and all that kind of tommy-rot you know, and have one more good laugh before the combined assault of the butcher, the baker and candlestickmaker, push us out of sight altogether. On one of these jocund occasions, we met Bill and his wife bent on the same errand. Naturally, we found seats in the same row, and after the show, Bill proposed that we go to some restaurant and have refreshments. We found a place right handy and the two ladies were soon deep in an animated discussion of babies, past, present and —. Bill and I confined ourselves to something we were both better acquainted with.

I said, "It's a funny way the world is divided up. Here's you and me and millions of other decent, sober, hardworking, law-abiding citizens, and all that kind of thing—if you get what I mean—and if we leave the beaten path, make a mistake, or act silly, we lose our job or get arrested or something. And here's this Charlie fellow gets a million dollars a year just for doing that very little thing."

"Well," said Bill, "I am not one of these statistical fellows who can prove everything by figures, but I know he can make me laugh when I am feeling blue; and I don't care how he does it or how much he gets for doing it. Did you ever go home at night from the shop, feeling like chucking the whole thing and going out and getting a job driving a truck or something? After you are cleaned and fed you begin to think that things might be worse. Then you go to a show and laugh until you get a pain under your wishbone. Why your troubles vanish like rubbing a damp sponge across a slate and you go to work in the morning with a clean, fresh mind ready to look at everything in a new light. This trick of getting a new slant at a thing is a very handy performance, sometimes. You see a job made the same way for years and then something happens to set you thinking. You take the casting in your mind and turn it sideways, endways and upside down, and in a good many cases you will find that the method of molding can be improved upon.



"Take the sleeves for connecting water pipes, for instance. I have seen them made in shops where they specialize in that kind of thing, and they certainly can turn them out by the mile. Making them there by the thousand and making a few hundred in a jobbing shop, are two different propositions. I worked in a place one time where they made a few of these, off and on. They had patterns for each size that dated back to the time the water system was installed in the town. There were all sizes, from 4 inches up to 30. The ones I am talking about were 6, 8, 10 and 12 inches. Now the usual way to make these is off a split pattern with a dry sand core. The core is made in halves and pasted. As everybody who uses pasted cores knows, it is practically impossible to get a round core that way. For rough work, where there is lots of room to go and come on, it does not make much difference. But even in those cases, a man who has any pride in his trade and likes to turn out true and accurate work, does not like to see the end of a piece of pipe, with fins on the ends, look as if some one took it while hot and jammed an irregularly shaped plug in the end.

"Then again you have to cut the bars in the cope for the top half of the pattern. If the guides are not constantly looked after, the castings will show a shift. If there are soft spots under the bars there will be a runout and even if it is stopped in time to save the casting the joint of the flask and perhaps somebody's feet, will be burned.

"We had an order for a lot of these one time, and after making a few in the regular, orthodox way, I decided it was time for a change. I went over to the pattern shop and sat on the bench so that the patternmaker had to stop his work and ask me if I realized that I was sending the firm into bankruptcy by not only

loafing myself, but making him, as the lawyers say, an accessory.

"I said, 'Not at all, John, not at all. You may *think* I am loafing but I am right busy on the master's business. I have with me the germ, the seed, the embryo, the making, if you like, of a cute little plan to cut all the trouble out of that sleeve job, and make it a joy and delight, and incidentally help our kind benefactor put away a few dollars against the proverbial rainy day.

"I doubt if the last argument had much weight with him, but anyway he said if he could be of any help in developing the seed, he would be only too happy to spread the fertilizer, or words to that effect. You don't find many patternmakers like that. Instead of telling me that the present patterns were all right and if the bunch of molders I had were any good, they could get good castings off them, and all the other stock arguments which are good for starting a fight, but not much good for anything else, he very politely said: 'All right, Bill, shoot.'

"'Well, John,' I said, 'I am a modest man and don't want all the glory for this thing. So if the idea works I will divide the honors and medals and things with you and see that you are mentioned in dispatches. I will give you the general idea and you can work out the details. That's fair enough, eh?'

"'Oh, sure,' said John, 'Make an incubator of me. It will take you about five minutes to lay the egg and it will take me about a week to hatch it and nurse it along.'

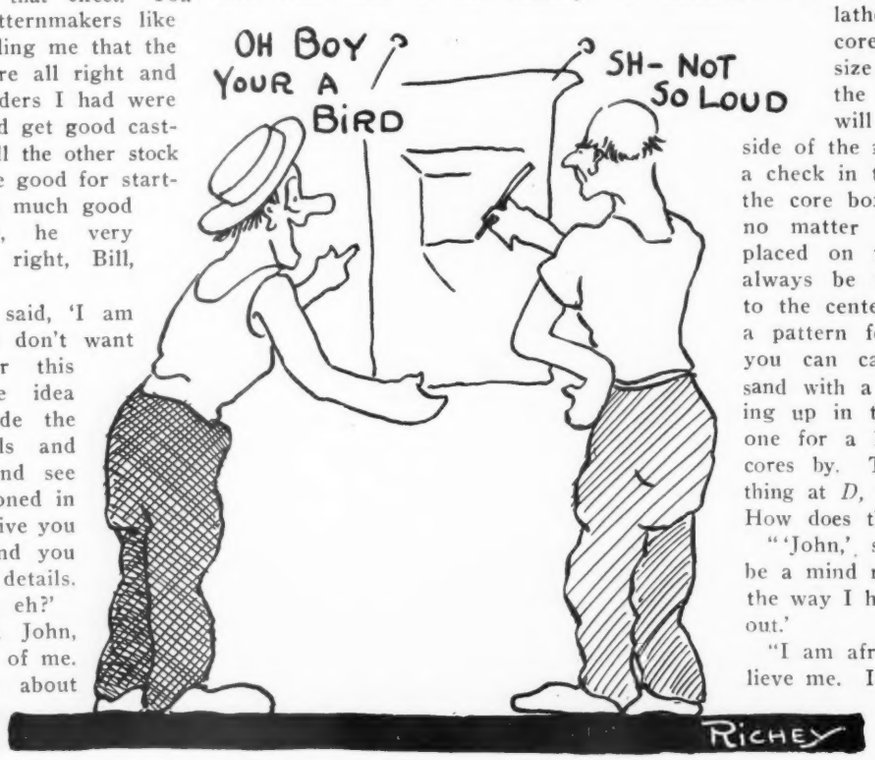
"'Corporal,' said I, 'I knew I could depend on you. Now briefly, here's the idea. We will make new patterns so that the job can be molded on end, requiring only plain, flat copes. Have the bottom flange made loose and in, say three or four pieces, so it can be drawn-in after the main pattern is drawn. Have a core print in the bottom only, with a conical prong in the center, to act as a guide in locating the core. Then make a hinged core box, some lifting plates, and there you are.'

"'As nearly as I can get the idea,' said he, 'it will work out like one of those problems which Archie Euclid used to delight in. Let *A* be the given casting—the proposition is to supply a pattern and core box which can be packed with green sand and when brought into proper juxtaposition with each other, will form a receptacle or mold which, on being filled with molten iron, will form an exact duplicate of the given casting.'

"I told him I didn't know what he was talking about, but that I got his meaning perfectly. Furthermore, I told him it was a great idea and to go right to it.

"'Wait a minute,' says he, 'until we get a sketch of this thing and we will have a better idea of where we are at.'

"John is some sketcher. Before he was through he knew better than I did what I wanted, and having arrived at that happy point I left him and went back to the foundry. I went over again next day and John showed me the sketches, transferred to the laying-out board, life size."



JOHN IS SOME SKETCHER

Here Bill produced a stump of a pencil and proceeded to illustrate on the back of a menu card as he went along.

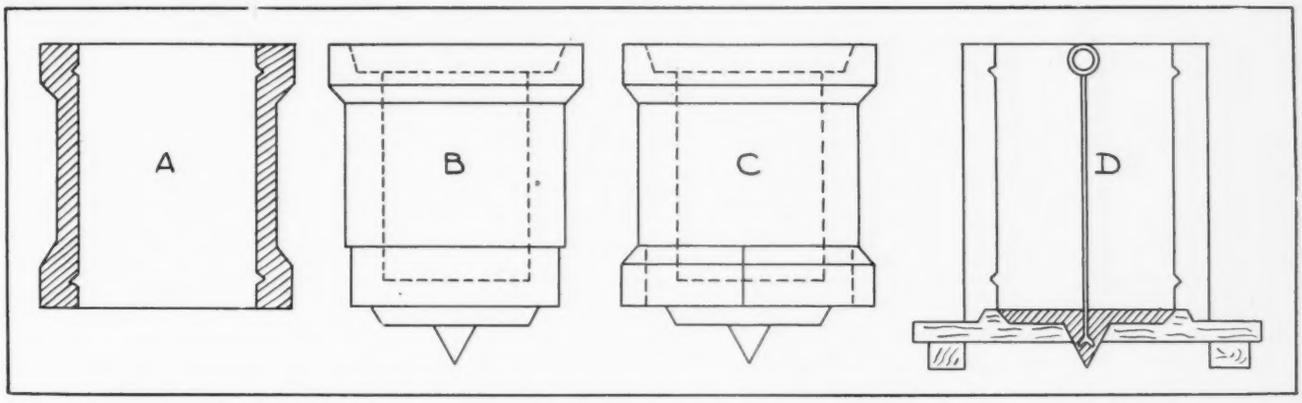
"As nearly as I can remember, John delivered a monologue something like this: '*A* is the casting, *B* is the main pattern which will be built-up in segments and hollow. I will turn a check near the lower end to receive and locate the bottom flange. This flange to be in three, four or more pieces, depending on the size of the pattern. I will turn a shoulder inside the top end, one inch down, and fit a cover into it like a trap door. The bottom end, of course, will be solid and carry the core print. When assembled ready for molding, it will be as at *C*. On account of the V-shaped grooves near each end, the core box cannot be lifted off; neither can the core be lifted out of the box. Therefore, I will build up the core box *D*, turn it out true; then saw it in two, assemble it again and put hinges at one joint, and hooks and eyes on the other. When the core is made, you can just open the hooks, swing the two halves apart horizontally and lift out the core. The next thing is to have some device to locate this ring definitely in reference to the core print. I will make a square bottom board for the core box, with two battens on the bottom side. On the other side I will fasten a ring, say ¾-inch high, and the same thickness. I will put the board in the lathe and turn out a core print the same size as the print on the patterns. Then I will true up the outside of the ring to conform to a check in the bottom end of the core box. Thus, you see, no matter how the ring is placed on the board, it will always be right in reference to the center. I will turn up a pattern for a lifting plate, you can cast them in open sand with a ½-inch rod standing up in the center of each one for a handle, to lift the cores by. There is the whole thing at *D*, ready for the sand. How does that strike you?'

"'John,' said I, 'you must be a mind reader. That's just the way I had the thing doped out.'

"I am afraid he did not believe me. In fact he was rude enough to inquire suspiciously, 'If you had the details all doped out, why didn't you give them to me in the first place.'

"There is a proverb to the effect that speech is silver, but silence is golden. I am a strong believer in the gold standard and also a strong believer in proverbs—some of them. However, I did not use either one as a subterfuge in this case to gain my end; I simply reached into a convenient pocket and offered John one of my cigarettes and his face was instantly wreathed in smiles. "You are quite a nuisance sometimes," he said, "but your heart is in the right place." Having thus got myself in right again I went back to the foundry and had a bed prepared on which to cast the lifting plates.

I cast a dozen plates for each size and put one of the boys on the job. It was a pleasure to look at the castings. Not



BILL SKETCHED THE SLEEVE PATTERNS ON THE MENU

a wing, or a fin, or a whisker on them; no drops, crushes, shifts or run-outs. Every one perfectly round and every one exactly alike."

Here Mrs. Bill butted in and said, "Well, I hope all husbands are not alike. I don't want to get another one like you, keeping us waiting here all this time while you talk about that tiresome old foundry."

"Tiresome is right," said Bill, "let's go home."

Develops Plan to Build Ships of Steel Castings

SHIPS constructed wholly of steel castings which are firmly united by autogenous welding are being planned as the result of exhaustive experiments conducted by the Cast Steel Ship Corp., New York. On first thought it would appear that a ship built in this manner would be too heavy for practical purposes, yet the company points out that its cast-steel type of ship would save 20 per cent of the first cost and would have a carrying capacity 4 per cent greater than that of vessels built from rolled plates.

Among the most efficient steel ships of the Isherwood type being built of rolled steel in this country today, the ratio of steel in the hull to deadweight cargo capacity is 1 to 4 for a 10,000-ton vessel. The cast-steel ship, it is stated, will carry between five and six tons of cargo per ton of steel in the hull. This increase in cargo carrying capacity is based upon the fact that the angles, clips, etc., necessary to join the plating and framing of the riveted ship's structure are eliminated. The joints between the plating and framing of the cast-steel ship are to be cast without excess metal.

Time Saved in Assembling

Great advantage, it is claimed, will result from the much smaller number of parts of which the cast-steel ship is to be built. In the ordinary rolled steel vessel of 10,000-ton capacity, there are more than 20,000 major parts, including plates and angles, to be fitted and riveted. The cast-steel vessel of similar deadweight capacity will have less than 2000 major parts, thus permitting a great saving in assembling time.

The design of the cast-steel ship differs from that of the ordinary steel ship in that the framing in the forward and after bodies is at right angles to the shell. This form of design was adopted in order to do away with the multiplicity of molding equipments that would be required to provide for the different angles formed by the junctions of the ordinary framing and shell. By this design it is possible to make all castings for the ship, except those in the bilge, with one molding outfit, in which the thickness and depth of the framing may be varied in the sand. As shown in Fig. 1, the framing is cast solid with the shell.

Methods of production already have

FIG. 1—TYPE OF STEEL CASTING USED IN THE SHELL, TANK TOP, BULKHEADS AND DECKS—THE T-SECTION AND RIBS INSURE STRENGTH

been standardized. Castings for either the transverse or longitudinal system of shipbuilding, and for ships of almost any size are possible. One large mold comprising a number of units may form the castings for the shell, deck, tank top and bulkhead with extra equipment for bilge forms and other details. In making ship castings for the Isherwood system, sections may be cast from one main transverse frame to and including the next. The castings for the side of the hull, for the bottom, tank top, decks and bulkheads are of the same type, each including the plating and the corresponding portion of the transverse frames, beams or stiffeners, and each including also the corresponding portions of the longitudinals and of the margin plates or girders, as the case may be.

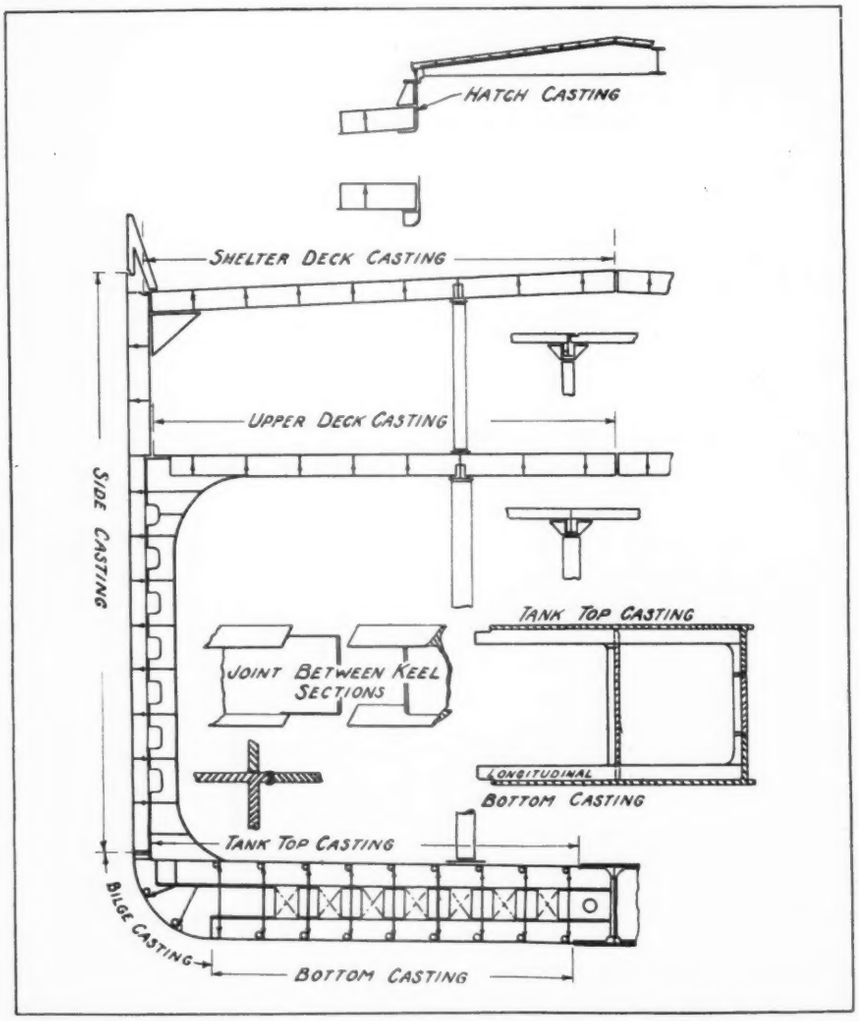


FIG. 2—MIDSHIP SECTION DETAIL SHOWING ARRANGEMENT OF CAST-STEEL MEMBERS

The bottom has two castings, one from either side of the keel casting to the bilge casting. The tank top has the same number. A side casting of the hull extends from the bilge casting to the gunwale. These castings are varied in design to meet the requirements of the hull in the forward and after bodies but the general system is the same. The deck castings are nearly duplicates of the tank top castings, with some variation in size where they meet the hatchway castings. Their edges are modified in the fore and aft bodies, by shaping the sand in the molds to fit the curves of the hull at the deck levels. Bulkhead castings resemble the side castings of the hull, being provided with similar longitudinals and also vertical stiffeners.

The thickness of the various parts of the different castings may be altered to suit hull requirements by scraping off more or less sand from the mold surfaces, according to the thickness desired. The mold units are prepared by a sweeping process, no solid patterns being necessary.

The flasks are permanent and of such shape that only a small amount of sand is required for each mold. This, it is claimed, obviates the necessity for skilled molders and reduces the amount of manual work per ton of castings to a minimum. For pouring the thin sections which characterize these castings, a deoxidized steel will be employed. This is produced in an electric furnace. The steel in these castings contains 0.25 per cent carbon, has a tensile strength of 70,000 pounds, an elastic limit of 38,000 pounds and an elongation of 28 per cent in 2 inches. Fig. 2 shows a detail of a cast steel midship section, illustrating the arrangement of the cast-steel members.

Through a syndicate of shipbuilders, the Cast Steel Ship Corp. expects to cover its foundry needs. The first castings are being made in Chicago, the ship to be assembled on the Atlantic coast, within the next few months. Owing to the speed with which vessels of this kind are expected to be assembled, it is thought that one or two ways will suffice for assembling and launching a large tonnage.

The Cast Steel Ship Corp. was recently organized under the laws of New York state, with offices at 114 Liberty street, New York, to establish the production of cast-steel ships as an industry. The president of the company is Myron F. Hill, who has been a member of the committee on welding of the Emergency Fleet corporation. Mr. Hill, who is the inventor of the cast-steel ship and who designed the methods to make their production possible, originally undertook this project to supply a new source of material and labor for ships. The Cast Steel Ship Corp. will act as naval architect only.

Building Plant Extensions

The Hammond Malleable Iron Co., Hammond, Ind., is making extensive plant additions. A new 2-story core room, 165 x 65 feet, brick and steel construction, will be occupied about June 15. This core room will employ about 75 men to start. It is planned also to double the size of the milling, trimming, inspecting and shipping departments and construct a new pattern shop and office building. The old core room will be extensively remodeled and converted into a carpenter shop and a storage department for raw materials.

National Malleable Moves

The National Malleable Castings Co., Cleveland, is engaged gradually in transferring operations from its old plant to the new and completely equipped establishment at Woodhill road, which was described in the April 15 issue of THE FOUNDRY. It is intended that the old plant shall be entirely vacated, including the general offices, by July 1. For the present the offices will be maintained at the old plant.

Alloy Foundry Run Under Scientific Direction

How the Operations of a Large Aluminum Castings Plant Are Directed From a Central Laboratory—Research Work Prominent

ONE of the outstanding characteristics of industry at the present time is research. Nonferrous alloys have been used since the bronze age in prehistoric days yet more has been learned about them in the past 50 years than was developed during all previous history; due largely to research and the subsequent publication of results.

Research work has been a paying investment for the many companies controlling laboratories and it was formerly the universal custom to operate such laboratories in the greatest secrecy and for the sole benefit of their owners. But recently it has been discovered that secrecy and narrow selfishness do not bring the best results in this work, so the facts brought out by successful investigations are more and more being given out to industry in general through papers before engineering societies and in the technical press.

A contrast to this old general policy of secrecy is found in the laboratories of the Aluminum Castings Co., Cleveland. There is no guard at the open door, nor are there any *keep out* or similar signs on any of the different branch laboratories; instead everything is open and there are no private rooms or corners.

This laboratory has been established to work out problems connected with the melting, alloying, molding, and use of aluminum castings. It also deals with problems connected with adapting this metal to various uses. After these uses have been established the laboratory also works out methods of controlling the operations in the foundry so as to insure uniform results from day to day.

Working on the different problems are a hundred experts, trained specialists in their various lines; men with practical shop experience work in conjunction with technically educated collegians with doctor's degrees. A new 2-story building covering 22,000 square feet of floor space has been built to accommodate this staff and its equipment. The second floor, which extends over about one-half of the ground floor is devoted to offices and a small drafting room. On the first floor are all the laboratories, the drafting room of the automotive section, a foundry and a machine shop. It has been realized that a man without proper apparatus is badly handicapped in research work and every facility in the way of scientific instruments, testing machines, and tools has been provided.

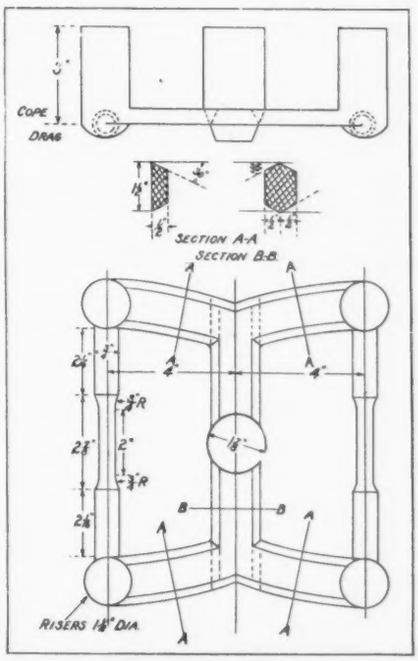


FIG. 1—DIMENSIONS AND GATING OF TEST PIECE

Walking through the laboratories seeing so many men busy on apparently unproductive work the question comes up, "What are they all doing?" Years ago this would have been considered an impertinent question and would not have received an answer, but the same question is readily replied to at the Aluminum Castings Co. laboratories.

Some of the problems which have been worked out and are still being investigated may now be mentioned. The subject of cores is one on which much has been learned but which still offers an almost endless field for research, mostly along the line of

FIG. 2—ONE SIDE OF THE PHYSICAL TESTING DIVISION SHOWING SOME OF THE MACHINES

the best sand for the purpose and the right core compound for use with the various sands. Temperatures constitute another broad question. What is the best melting temperature for each of the alloys? What is the correct pouring temperature? Must the temperature be changed when a different flux is used? This brings in the question of the best flux and whether various fluxes are necessary for different alloys. There is a big difference in price between scrap aluminum and the virgin metal, and whoever finds a means of cleaning scrap aluminum of its dissolved gases and dross, making it as good as new metal, will be handsomely repaid.

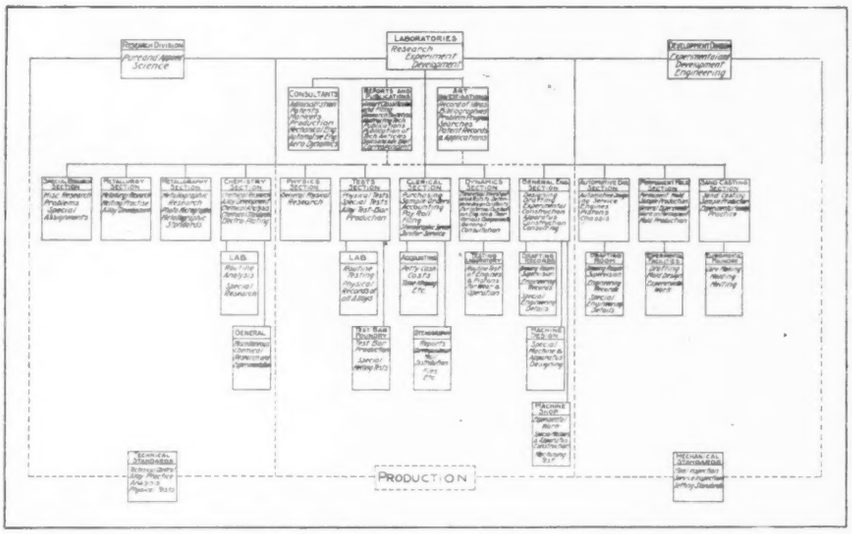


FIG. 3—CHART SHOWING THE ORGANIZATION OF THE LABORATORIES, DIVIDED INTO THREE SECTIONS

Another one of the activities of this laboratory includes testing and establishing the design for various castings. But probably the laboratory's most important work is found in the efforts constantly being made to develop new alloys. Experiments have been made on alloying aluminum with vanadium, iron, copper, cobalt, magnesium, manganese, and zinc in different proportions. Then combinations of two or more of these metals with aluminum have been tried. So far six alloys have been developed and standardized for different purposes according to their strength, ductility, rigidity and casting qualities.

The old No. 12 alloy consisting of 8 per cent copper and 92 per cent aluminum has a tensile strength of 19,000 pounds per square inch and an elongation of 2 per cent in 2 inches. In addition several other alloys consisting of various percentages of aluminum, copper and other metals, have been made and standardized. The tensile strength, hardness and other properties of these alloys vary. In each case, however, the question of the ease of casting, the nature of the design and use to which the finished product is to be put determines the proper alloy to be used. In certain cases tensile strength may be the important factor while in others this factor is less important because other characteristics are desired in the finished product.

The personnel of the laboratory is organized so as to handle the work systematically and each department has its assigned duties, in order to avoid interference among the different divisions. There are three general departments: One carries on research in the arts of alloying and melting nonferrous metals; another studies how to adapt scientific principles to commercial uses; while the third division controls the foundry practice to obtain and maintain the specified qualities and standards The three main departments are again subdivided as shown in the chart, Fig. 3. As has been previously indicated, the laboratories are all located on the first floor of the building. They include a physical, metallurgical, dynamic, physical testing and two chemical laboratories.

In one of chemical laboratories, Fig. 4, analyses are made and experiments are carried on in a small way. In the other investigations are undertaken more nearly on a manufacturing basis. A glass blowing outfit has been set up to take care of the needs of the laboratories in this direction.

Fig. 2 gives an idea of the scope of the physical laboratory although only a portion of this laboratory is shown. To the left is seen a 50,000-pound universal testing machine and two 10,000-pound machines. These machines were built by the Tinius Olsen Testing Machine Co., Philadelphia. They are used to test the physical properties, under tension and compression, of the various alloys. Tensile tests are made on alloys at various temperatures to find out how the metal is affected by heat. Small test

FIG. 4—ANALYTICAL LABORATORY, 18 x 20 FEET, IN WHICH FIVE MEN WORK—NOTE THE COMPACT ARRANGEMENT

FIG. 5—METALLOGRAPHY LABORATORY—POTENTIOMETER ON THE TABLE TO THE FRONT

pieces are used. They are put in the holders seen in the 10,000-pound machine to the right in Fig. 2, and a cylindrical electrical resistance furnace is placed around the holders. This furnace heats the test piece to any desired temperature which is indicated by a pyrometer the couple of which is located near the test piece.

On the large machine, standard test pieces, the outlines of which are shown in Fig. 1, are pulled. The ends of these test pieces are threaded to fit the holders but the test length is not machined and is pulled as it is cast. The dimensions of the test piece are the same as adopted by the American Society for Testing Materials in its tentative specifications for light aluminum castings. The method of gating, illustrated in Fig. 1, has been found to give a test bar which will show concordant results. Two test bars are cast for each test in order to get an average.

With these bars, the relative tensile properties of different alloys can be found, but a test on a bar will not tell the full story of the alloy in a casting, even though many test pieces are cut from different parts of the casting. For this reason the Aluminum Castings Co. has decided to test some of the castings themselves to see just what loads they will stand. To do this a 200,000-pound universal testing machine made by the Riehle Bros. Testing Machine Co., Philadelphia, is being installed.

Beside the static tests, impact tests are made on a modified form of the Charpy single-blow machine manufactured by Sauveur & Boylston, Cambridge, Mass. Endurance tests are made on a White-Souther machine furnished by the Tinius Olsen Testing Machine Co., Philadelphia. This machine can be seen in the center of Fig. 2.

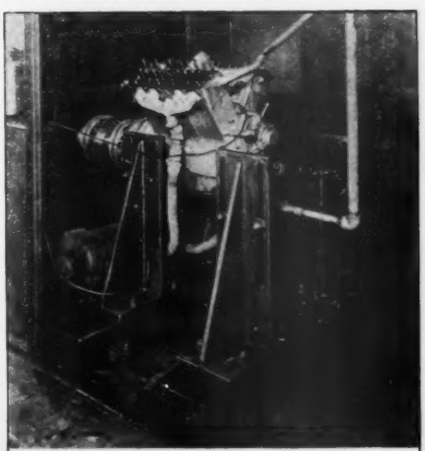
A Stanton repeated blow impact testing machine, furnished by the Cambridge Scientific Instrument Co., Cambridge, Eng., is used to test the ability of metal to withstand repeated shock. A specimen ½-inch diameter, supported by knife edges 4½ inches apart, is struck repeated blows by a hammer weighing approximately 3 pounds. The height of the fall of the hammer may be varied up to 4 inches and the weight of the tup may be changed. In this way the test piece can be broken quickly or it may stand up under several hundred thousand blows, and the effect of a few severe shocks or of many slight shocks can be noted. To the right of Fig. 2 are a Brinell machine and a scleroscope for testing the hardness of metals.

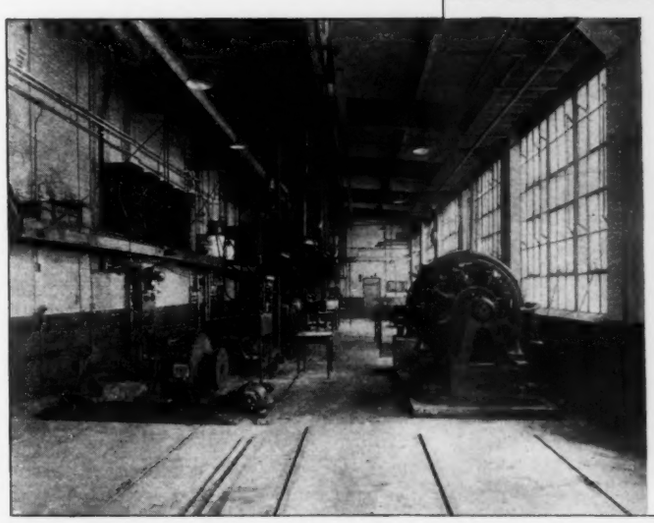
Connected with the physical testing laboratory there is a small foundry which is used for making experimental alloys and test pieces for the laboratory. The company also has a special foundry in which samples of all new products are cast and no new product is turned into production until its practicability and the best method of molding it have been established through trials in the experimental foundry.

The laboratory in which metallographical work is done is shown in Fig. 5. It is equipped with electrical furnaces for heat treating samples and with miscroscopes and cameras. In the foreground, Fig. 5, is a potentiometer made by Leeds & Northrup Co., Philadelphia. This is used to measure the electromotive force in thermocouples when very accurate and close temperature measurements are required.

While the other divisions of the laboratory are mainly devoted to the testing of materials, the dynamics division, Fig. 7, tests the finished product. The channels in the floor make a bed-plate the entire length of the room on which machines can be set up at will. In the front, to the left, is an Alden absorption dynamometer for testing motor-car rear axles. Back along the wall to the left are three electrical dynamometers of 100, 200, and 400 horsepower, furnished by the Sprague works of the General Electric Co., New York. A view of the two larger dynamometers with their switchboards and rheostat control is shown in Fig. 8. Attached to the 400-horsepower dynamometer, in the air duct to the right, is one of the new engines which is being tried out. Fig. 6 gives a view of this engine. When on test varying amounts of air can be drawn over the engine up through the air duct to determine the effect of different degrees of cooling.

On the same plot of ground on which the new laboratory is located the Aluminum Castings Co. is building a large aluminum foundry cover-





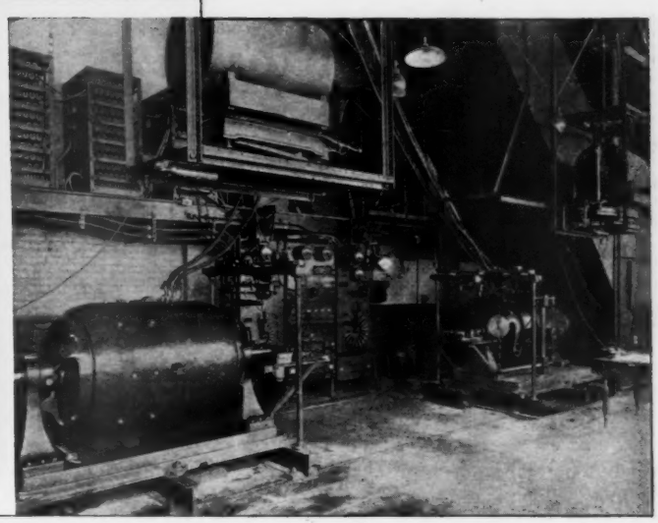


FIG. 6—MOTOR ON TEST TRYING OUT NEWLY DESIGNED PARTS FIG. 7—GENERAL REVIEW OF THE DYNAMICS LABORATORY FIG. 8—TWO OF THE ELECTRICAL DYNOMOMETERS WITH THEIR SWITCH-BOARD CONTROL

ing a floor space of 150,000 square feet. This foundry will have a thoroughly worked-out conveyor system and an effort will be made to provide the most modern foundry equipment.

Fusion in Arc Welding

In the production of welds by the electrode process, a fair estimate of the fusion may be obtained by an examination of the surface of the deposited metal and the depth of the arc crater formed when welding at normal speed, it is stated in a paper by O. H. Eschholz presented before the American Institute of Electrical Engineers. The two prime characteristics of fusion are penetration and overlap. To insure satisfactory fusion a proper degree of penetration should be obtained without getting any overlapped condition.

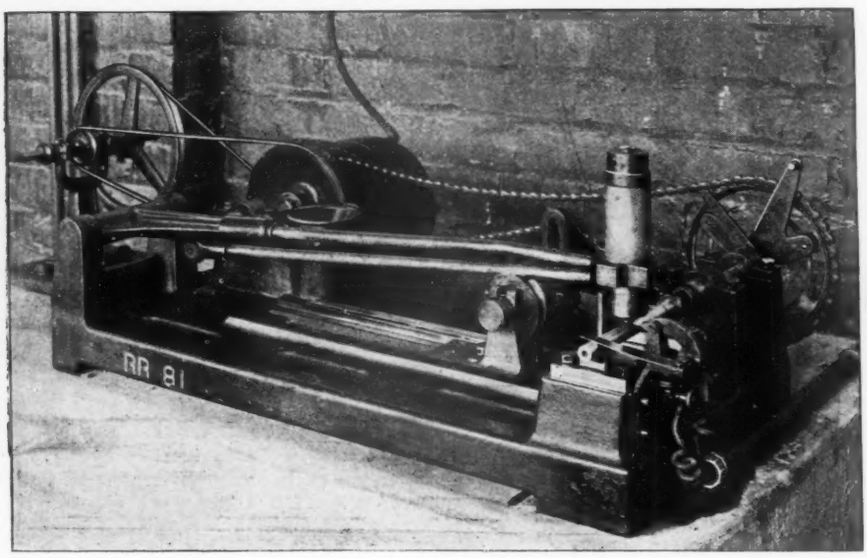


FIG. 9—STANTON REPEATED-BLOW IMPACT MACHINE USED FOR TESTING ALLOYS BY THE ALUMINUM CASTINGS CO.

The effect of arc length on fusion is a moot point between welding engineers. With a short arc the plate metal s liquefied by the energy required to maintain the arc crater, by that conducted from the arc flame in constant intimate contact with the plate and by the energy radiated from the arc stream and electrode terminals, as well as by that absorbed from the molten electrode deposit. When the molten material passes through a short arc it is completely enveloped in hot gases and suffers but a slight loss in temperature before being deposited.

Upon drawing a long arc the air currents in its vicinity blow the arc stream and the arc flame about so violently that it is difficult to maintain the plate terminal of the arc in a given position long enough to effect sufficient penetration. Moreover, the energy absorbed from the arc stream and electrode terminal becomes practically negligible, due to the greater diffusion of the radiation in the region of the arc plate terminal, while the energy absorbed from the molten metal is decreased because of the loss of temperature the deposit has sustained in transition.

The melting point of most weldable steels may be gaged with sufficient accuracy for welding purposes by the carbon content. The usual additions of alloying ingredients reduce the melting point a negligible amount. For electrode purposes a commercially pure iron is quite satisfactory. Under exceptional conditions, it is customary to preheat the object to be welded. For a given plate thickness, the welding current will vary with the type of weld scarf, cleanliness of surface, thermal capacity, conductivity of the metal and position of the plate with respect to the welder.

A close adjustment of electrode diameter to arc current is not essential. For miscellaneous direct-current welding, the densities usually fall within a range of 7000 to 10,000 amperes per square inch, if an 0.18 per cent carbon steel electrode is used. With too great an electrode diameter for a given current, the arc becomes more unstable, increasing the manipulative skill required and decreasing the rate of depositing electrode material. Too small a diameter causes a deposition of electrode material before the plate has been properly liquefied; it also increases the skill required to prevent the electrode from freezing to the plate. With the correct diameter the electrode material is sprayed in a regular stream at a rate which will insure maximum welding speed consistent with good fusion.

The fusion obtained in arc-welded joints between the plate and deposit metals is determined by the penetration of the deposit metal into the plate metal and the overlap of the edge of the deposit layer on the plate. The penetration is comparable to the depth of arc crater as observed by the welder when moving the arc terminal over the plate with uniform velocity; and the overlap is indicated by the contour of the surface of the congealed deposit in the region adjacent to the material welded. For most welds a crater depression of $\frac{1}{8}$-inch will give the desired penetration while a contour which does not show a re-entrant angle between plate and deposit indicates an overlap per layer of approximately $\frac{1}{32}$-inch or less.

Influence of Slag on Open-Hearth Steel Castings

(*Concluded from page 376*)

rium, without making matters worse by causing the slag to pass more iron oxide into the metal as a result of the addition of lime to the slag. If the slag be still very thin at the end of the process, carbon, silicon and manganese losses cannot be properly controlled, owing to the excessive amount of dissolved oxygen in the metal, and if the charge be tapped under such conditions and normal finishing additions made either to the furnace bath or in the ladle, the percentage of these elements will be found to be low in the sample, and if the silicon be very low blowholes may result in the castings.

When a very mobile slag highly basic with iron oxide is obtained and there is insufficient carbon in the bath to effect the reduction of the excess iron oxide present in the slag and metal, equilibrium can only be acquired by recarburizing the bath with sufficient low phosphorus pig iron to reduce the excess iron oxide, both the carbon and silicon of the pig iron being available for this purpose. The advisability of working the furnace at as high a temperature as the refractories will withstand, during both melting and oreing periods, cannot be too greatly emphasized, as by this means the occurrence of such an undesirable slag is most readily obviated.

The presence of an excess of lime in the slag may sometimes be due to the melter having attempted to thin a dirty slag, caused by patches of sand from the furnace hearth, or by the refractory bricks of the furnace having fused and run into the bath owing to the furnace having been worked at an excessive temperature. The employment of limestone for such a purpose is useless, for the lime only combines with the slag proper, and has no effect on the foreign siliceous matter which rests on the surface of the real slag. Instead of adding limestone, the slag should be cleaned by the workmen raking off as much of the siliceous matter as he is able to collect.

British Foundrymen Welcome President of A. F. A.

Three Special Dinners and Meetings Held at Coventry, Sheffield and Birmingham—Various Technical Societies Participate—Plants Inspected

DURING his recent visit to Europe, the president of the American Foundrymen's association, A. O. Backert, was the guest of honor at a series of dinners and other formal and informal functions tendered by British technical societies and their representatives in recognition not only of the important position of the American foundry and allied industries in the world of business, but of the sincere spirit of co-operation and friendship existing between the great English-speaking democracies of the old and new world.

Three meetings were arranged by the British Foundrymen's association in Coventry, Sheffield and Birmingham, on April 30, May 3 and May 5 respectively. At Birmingham, the Staffordshire Iron and Steel institute, the Birmingham Metallurgical society and the British Institute of Metals co-operated in a joint dinner and meeting. The Sheffield gathering was a national affair in which members of the British Foundrymen's association from London, Birmingham, Coventry, Derby, Peterborough, Mansfield, Keighley, Manchester, Loughborough, Leicester, Newcastle-on-Tyne, Luton, Dumbarton and numerous other points in the United Kingdom participated.

In addition a number of plant inspection trips were arranged, including the Wicker Iron Works, Hadfield's, Ltd., Edgar Allen & Co., and Steel, Peech & Tozer at Sheffield; the great Daimler Works and the plants of Alfred Herbert, Ltd., Rowland Hill & Co., and the British Piston Ring Co. at Coventry; the Birmingham Iron exchange, Walter Somers & Co., and other works in Birmingham; the Leys Malleable Castings Co., Derby, and the works of the Rolls Royce Motor Co. At several of these plants the American flag was hoisted in honor of the visitor as a representative of the United States.

Centrifugal Casting Method

A number of interesting British technical developments were specially pointed out to the visitor during the plant inspection tour. At the works of Alfred Herbert, Ltd., machine tool manufacturer, Coventry, a densifying arrangement for improving the surface of fine machine tool castings was exhibited. A number of heat-treating furnaces in which it is possible to treat the material in a neutral atmosphere and plunge it into an oil bath without allowing it to come into contact with the outside air also were in operation at this plant. At the Daimler automotive works in Coventry the method invented during the war for making steel links for tanks was explained. The Daimler laboratory also was visited. This is one of the largest research laboratories connected with an industrial establishment in the world. It is in charge of W. H. Pickin, who has 10 assistants in the mechanical laboratory, six in the metallographic department, with eight workmen engaged solely in the preparation of samples for testing. At the plant of the British Piston Ring Co., Coventry, which also was visited, a new machine for casting piston rings without the use of sand, by a centrifugal process, has been installed. This machine is provided with a rotating barrel or cylinder in which it is possible to produce piston rings ranging from 4 to 30 inches in diameter, the number of revolutions per minute of the machine being regulated by the size of the casting. The molten metal is poured from a special tilting device into the rotating barrel in such a way that it is molded into the proper form by centrifugal force. At the Hadfield foundry in Sheffield special methods for heat-treating steel castings were examined and large hydraulic molding machines used for various purposes were shown in operation.

After the plant inspection tour at Coventry a complimentary dinner was given by the Coventry branch of the British Foundrymen's association, on Wednesday, April 30, at which the following guests were present: Henry Smith, E. M. C. Instone, J. K. Starley, O. Harmer, G. H. Henson, A. Harley, F. H. Hurren, E. H. Broughall, A. Craig, R. Buchanan, F. J. Cook, J. R. Handforth, G. Williams, P. J. Dawes, C. B. Pugh, T. Vickers, W. Birkett, R. C. Bullock, G. Roberts, A. T. Linnett, F. H. Lane, E. Whitworth, A. Harrison, W. Jacques, A. Fraser, H. Toplis, A. S. Lancaster, C. C. Hanch, J. C. Percy, A. H. Niblett, Captain Smith-Clarke, T. W. Picker, E. N. Boote, G. Needle, T. G. John, W. Binnie, J. W. Rushforth, T. W. Miles, D. Cartwright, E. Cox, C. Burnett, A. E. MacIntosh, D. Sharp, J. Buchanan, A. Stynes, S. Corden, L. Haxby, J. Horton, G. Rollaston, R. C. Mountfort, M. Wild, E. Carey Hill, A. P. Smith and A. O. Backert. Harry Smith of the Rover Co. presided, this company co-operating with the Daimler company in acting as host.

Mr. Backert was warmly welcomed by Andrew Harley, president, Coventry branch, B. F. A., who proposed a toast to the American Foundrymen's association. He pointed out that it was the first occasion on which a president of the American Foundrymen's association had visited England in his official capacity. Mr. Harley said he sincerely hoped the brotherly feeling which has been created between the British and American people during the war will be perpetuated. The proper feeling, he pointed out, can only be secured by close co-operation between important British and American technical societies and business organizations, such as the American Foundrymen's association and the British Foundrymen's association. Mr. Harley concluded his remarks by wishing success to the American Foundrymen's association and inviting the guests to drink to the health of its president.

Wonderful Industrial Achievements

In responding, Mr. Backert expressed his appreciation of the unusual cordiality of his reception, which, he said, was a compliment primarily to the American foundry industry. He hoped, he said, that the day might soon come when the American Foundrymen's association could reciprocate in kind. The speaker also laid stress on the wonderful industrial achievements of Great Britain during the war, particularly in the castings field.

The dinner was followed by a general meeting of the Coventry branch of the British Foundrymen's association. Mr. Harley occupied the chair. In the address of welcome at this meeting it was pointed out that the British people are anxious to co-operate with the United States in a campaign to eliminate ignorance in trade and technical affairs through the free interchange of ideas, which would result in the establishment of a higher status not only of knowledge, but of life.

In response, Mr. Backert said in part: "When it comes to precision work and quality production, we Americans must take our hats off to the British foundrymen. I am specially impressed with the progress of British manufacturers in the heat-treating field. In some respects our development as regards the heat-treatment of castings in the United States is in its infancy. We feel we have a great deal to learn from Great Britain along this line, and the foundrymen of America certainly will appreciate the generous spirit of co-operation displayed everywhere throughout the United Kingdom."

A general meeting of the British Foundrymen's association, at which members from all parts of the country were present, was held at Sheffield on Saturday, May 3. It was presided over by Thomas H. Firth, Wicker Iron Works, Sheffield, president of the British Foundrymen's association. The complimentary dinner took place at the Grand hotel. The following guests were present: T. H. Firth, president, B. F. A.; Alderman W. Irons, J. P., lord mayor of Sheffield; Prof. W. Ripper, J. P, M. I. C. E., vice chancellor of Sheffield university; Capt. Mark Rundle, D. S. O., R. N.; Prof. W. G. Fearnside, M. A., Sorby professor of geology, Sheffield university; Maj. D. Gordon, R. A. F.; Capt. A. Hayes, R. A. F., general secretary, B. F. A.; W. Clarke; P. B. Brown, M. I. C. E.; P. Crosbie; J. M. Savage; A. S. Capron; J. M. Allan; C. E. Siddall; H. C. Else; A. Senior; F. J. Crowley; H. Newbould; J. Little; J. G. Crowther, past president, Sheffield branch, B. F. A.; T. W. Willis, president, Sheffield Society of Engineers and Metallurgists; W. Mayer, past president, B. F. A.; F. W. Finch, founder and treasurer, B. F. A.; J. D. Carmichael, president, Newcastle branch, B. F. A.; F. J. Cook, past president, B. F. A.; J. Shaw, past president, Birmingham branch, B. F. A.; H. L. Reason; J. G. Robinson; A. Whiteley, secretary, Sheffield branch, B. F. A.; Dr. P. Longmuir, past president, B. F. A.; Dr. W. H. Hatfield, president, Sheffield branch, B. F. A.; J. Watson; J. Ellis, past president, B. F. A., and A. O. Backert.

British Society's Growth

Addresses were made by J. M. Savage, lord mayor of Sheffield, P. B. Brown, W. Clarke, Capt. Mark Rundle, Dr. W. H. Hatfield, Prof. W. Ripper, John Watson, Thomas H. Firth and A. O. Backert. In the addresses of welcome and response, the importance of Sheffield as an iron, steel and foundry center was emphasized. The Sheffield district furnished 90 per cent of British steel requirements during the war. Mr. Firth, in introducing the guest of the evening, pointed out that the British Foundrymen's association, although founded only in 1903, now has 1600 members and is, therefore, the largest foundrymen's association in the world.

In responding, Mr. Backert referred again to the unusual warmth of his reception. He extended a cordial invitation to visit the international exhibition of foundry and shop equipment and the twenty-fourth annual convention of the American Foundrymen's association, which will be held in Philadelphia during the week of Sept. 29. Mr. Backert also sketched the foundry development of the United States and made a few remarks on the labor situation. He again expressed his interest in the great technical achievements of the British castings producers during the war and previously.

Dr. W. H. Hatfield and Prof. W. Ripper, vice chancellor of Sheffield university, both stated they greatly rejoiced in the growing friendship between the English-speaking peoples. They also called attention to the desirability of interchanging students between American and British technical institutions of learning. In the future, it was pointed out, it will no longer be necessary to go to German universities to obtain the degree of doctor of philosophy. During his stay in Sheffield, Mr. Backert was the guest of Thomas H. Firth at his residence in the outskirts of the city.

Joint Meeting at Birmingham

The final welcoming function tendered the president of the American Foundrymen's association was held at Birmingham, Monday evening, May 5. Dinner was served at the Queen's hotel, after which a general meeting was held at Birmingham university. The dinner and meeting were held under the joint auspices of the Birmingham branch of the British Foundrymen's association, the Birmingham Metallurgical society, the Birmingham local section of the British Institute of Metals and the Staffordshire Iron and Steel institute. Prof. Thomas Turner, Birmingham university, presided. The guests at the dinner included the following: Sir William H. Bowater, deputy lord mayor of Birmingham; Sir Gerard A. Muntz, Bart.; W. T. Gracey, American consul; H. L. Reason, president, Birmingham branch, B. F. A.; G. Carrington, president, Staffordshire Iron and Steel institute; F. C. A. H. Lantsberry, president, Birmingham local section, Institute of Metals; W. H. Henman, secretary, Birmingham local section, Institute of Metals; C. B. Pugh, secretary, Staffordshire Iron and Steel institute; C. H. Plant; E. Adams; J. Waddill; A. G. Smout; W. O'Keefe; H. Mantle; E. Carey Hill; J. Thomas; G. R. Leech; A. Spittle; H. Gregory; H. Field; R. H. Davis; Frank Somers; J. Fearn; D. H. Wood; D. C. Lloyd; T. Vickers, secretary, Birmingham Metallurgical society; R. Buchanan, past president, B. F. A.; J. B. Genders; Alex McKechnie; W. W. Geoch Jr.; J. B. Johnson; J. E. Foster; O. E. Riddell; S. Smith; J. H. Foy; H. Winterton; W. J. Flavell; C. Jones; C. B. Roe; F. Mann; J. J. Howell; R. Place; A. W. Jennison; J. R. Johnson; J. Horton; W. H. Garbutt; S. M. Hopkins; S. Evered; J. Payton; W. Fletcher; W. Smith and A. O. Backert. The toast to the king was proposed by Mr. Backert.

At the general meeting at Birmingham university, Professor Turner pointed out that the Staffordshire Iron and Steel institute is one of the oldest institutions of its kind in the world. The necessity for closer international co-operation along with technical and scientific lines also was pointed out by Professor Turner. A brief discussion of the qualities of malleable iron also took place. It was stated by Mr. Cook that the tensile strength of malleable castings made in British foundries averages nearly 60,000 pounds per square inch, these figures comparing unsually favorably with the results obtained in American foundries.

In his concluding address at Birmingham, Mr. Backert again expressed his appreciation of the warmth of British hospitality and his belief in the necessity for fostering closer relations between the productive industries of the United States and the mother country. He also referred to the great achievement of Professor Turner in the metallurgical field, saying that science is really the only international language. He also urged the promotion of closer relations between scientists and foundrymen in order to improve the art of making castings throughout the world.

New England Foundrymen Hold Meeting at Hartford

The New England Foundrymen's association held its May meeting at Hartford, Conn., the Hartford members acting as hosts. The program was intended to cover the full day and evening of May 21 but on account of an unusually heavy rain very few members showed up at headquarters at the Allyn House before noon and it was not until the dinner at 6 o'clock that all the visiting delegates assembled. At that time nearly a hundred men sat down together. George K. Ray, Taylor & Fenn Co., Hartford, was in charge of the entertainment and he staged an unusually attractive program. The weather, which had interfered with a long schedule of interesting machine shop and foundry inspection trips arranged by the hosts, did not interfere with the evening program.

In the absence of Fred T. Stockwell, secretary of the association, T. C. Wilson, of the J. O. Henshaw & Co., Boston, took charge of the business part of the program. He announced the names of Babcock Printing Press Mfg. Co., New London, Conn., and Springfield Brass Co., Springfield, Vt., as applicants for membership. These concerns were unanimously elected to membership.

Foundrymen interested in malleable-iron castings were attracted to Hartford by the paper on that subject presented by Enrique Touceda, consulting engineer, American Malleable Castings association, Albany, N. Y.

Mr. Touceda gave a comprehensive synopsis of the whole malleable-iron subject and by the use of lantern slides he very clearly illustrated the mistakes

which have been made and the precautions that are essential to good results in production.

The keynote of success in making malleable castings, Mr. Touceda said, is proper heat treatment and this means not only well designed ovens but a knowledge of the effects of different temperatures and different annealing periods upon the iron structure. This can only be gained through exhaustive tests and analyses. Mr. Touceda, to more vividly emphasize this point, outlined the work of the American Malleable Castings association, showing the great increase in tensile strength and ductility of the average malleable castings of today as compared with those of a few years ago. He also explained the importance of micrographs in studying results of tests. "Nearly the whole history of a specimen may be read in its micrograph," he said, and many foundrymen after listening to the glowing terms he used to describe some of these microscopic views, felt that Mr. Touceda could very probably deduce a specimen's future from them as well as its history.

Describes Chill Prevention

Perhaps a feature of Mr. Touceda's paper which was of especial interest to foundrymen was his illustrated description of the elaborate steps taken to prevent chill during cooling when a casting has light sections adjacent to heavy slow-cooling parts. Risers are placed at just the right points on the light sections so that the heat from the mass of metal which these risers contains will prevent any one part from cooling before the whole. Very often these risers are heavier than the entire remainder of the casting.

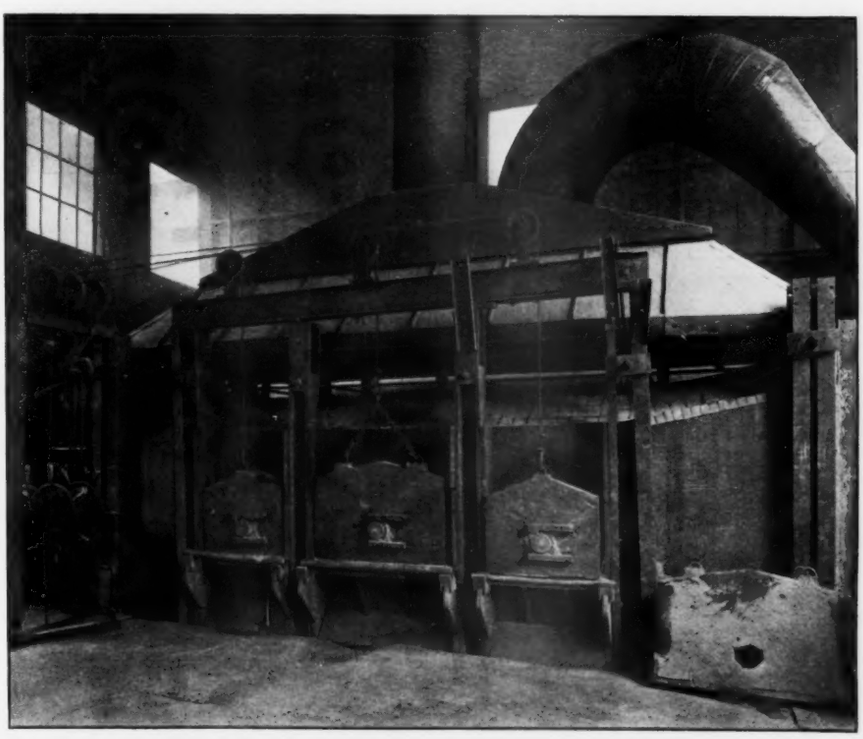
Mr. Touceda believes that most of the failures in malleable castings can be traced to carelessness or lack of understanding. Annealing furnaces often have the flue inlets arranged in such a way that the heat currents are short circuited in the same way as electrical currents may be; under these conditions one corner or side of the oven becomes excessively hot while other parts remain comparatively cool. This renders the oven wasteful of fuel and generally inefficient in its service.

In a correctly designed oven, the heat openings are spaced the full length of both sides. Precision in the control of annealing ovens is of great importance and for this purpose pyrometers are used to regulate the openings of the heating ports. By using a pyrometer in each corner of an oven and having each pyrometer control the heat ports in its locality a uniform temperature throughout the oven is assured at all times.

Foundry Utilizes Waste Heat From Open Hearth

ARCHITECTS who design buildings are accustomed to provide artificial means for heating them, but until recent years have given relatively little consideration to artificial ventilation. Lately more attention has been paid to mechanical means for ventilating and in a few cases a cooling system has been installed in conjunction with the heating and ventilating apparatus.

These greater refinements are usually in connection with banks, theaters, churches or other public places. But foundry managers are not far behind bank and theater owners in adopting combination heating and cooling methods to increase the comfort of their employes. Such a system installed by the National Foundry Co., Erie, Pa., is shown in the accompanying illustration. This system, although simple and inexpensive, has proved efficient. It consists of a sheet-steel hood over a 5-ton open-hearth furnace, with two pipes leading off from it. Both of these pipes are provided with dampers. The one extends from the hood perpendicularly through the roof. The other bends over to a fan from which it runs through a portion of the foundry, about 5 feet above the floor. Every 30 feet a 6-inch pipe leads off at right angles from the main conductor. These small pipes are 1 foot long and each one has a damper. They point down so that the hot air coming from them is directed to the floor of the foundry.



GENERAL ARRANGEMENT OF VENTILATING APPARATUS IN CONNECTION WITH OPEN-HEARTH FURNACE

In the summer the damper in the curved pipe is closed and the valve in the stack is opened wide. Under these conditions the hot air around the furnace makes a strong draft up the chimney, drawing in through the open windows the cool lake breezes which are characteristic of Erie in the summer. This to a great extent abates the hot working conditions around the furnace, without any operating expense whatever.

For heating the foundry in the winter the damper is closed in the chimney and opened in the other pipe; then the fan is started. This takes the hot air which is given off from the furnace and delivers it to different parts of the foundry, but does not in any way affect the working of the furnace. The distribution of heat is regulated by the dampers in the terminal pipes so that no part of the shop gets more than its share. The fan can be kept going continuously but if the weather is not freezing it is shut down at night and over Sunday to save the cost of operation.

Making Castings Used in Ship Construction--IV

Methods of Molding and Casting Rudder Yokes as Pursued in English Steel Faundries—Producing the Cores is an Essential Feature of This Work

By Ben Shaw and James Edgar

IN beginning the formation of the mold for the rudder yoke, whatever method may be adopted must have, as a preliminary, the preparation of the bed so as to define accurately the shape of the pattern. In many foundries the prevailing practice conveys the impression that preparing the bed, as it is termed, is of comparatively little importance. Let the molder, however, examine a number of large castings after they have been machined and the truth will dawn upon him that many difficulties with which the machinist has to contend are caused by the inaccuracy of the bed upon which the pattern has been laid. It is certainly impossible, in the present instance, to construct a pattern which would be absolutely rigid, hence, any inaccuracies in the preparation of the bed would be present in the casting. Many such examples could be mentioned, but it is sufficient to prove that the utmost care is essential in preparing a sand bed to receive a pattern of this character. Whether the pattern is to be bedded into the foundry floor and the work cast in that position, or prepared in a flask is of secondary importance, as the prepared bed is essential in each case.

If the major part of the mold is made in the floor, before the bed is constructed, it must be decided which side of the work is to be cast down. The same applies if prepared in a flask and cast on the flat. Fig. 1 shows the method adopted when the boss, as the highest point, is cast up. The making of the bearers is usually undertaken by the foundry doing the work, but sometimes firms sending out patterns, forward guide bars for the formation of the bed. However, it is better for the foundry to determine its own methods and to make tackle accordingly. The two bearers or guide bars shown, should be cut out together, being prepared as one so that they will be similar to each other in every respect, the rake, of course, being obtained from the drawing and not from the pattern. The steps at the ends provide a guide for squaring and levelling as indicated in the sketch. It simplifies matters to prepare roughly a level bed on which the guide bars are set parallel to each other, using the parallel straightedge against the steps to determine whether they are out of wind with each other, and a square to prove the steps at right angles to them. When the guide bars have been set satisfactorily, sand is rammed between and about them and strickled off to coincide with the guides. If it is decided to cast the rudder yoke in the reverse way, then the same procedure can be adopted, but the boss bearers would have the rake in the opposite direction.

Another method of preparing the bed is sometimes adopted and is illustrated by the dotted lines in Fig. 1. This necessitates the preparation of a level bed and since the bearers must be set accurately from the center, the services of the patternmaker usually are requisitioned to reduce the possibility of mistakes. While both these methods are adopted in general practice, the former method provides the safest means of insuring a reliable bed. This bed really is formed to receive the plate portion of the pattern, hence much of the bed will need to be cut away. In doing so, it is comparatively easy for the molder to twist the pattern and to avoid that difficulty, it is advisable to strickle-out a shape with trammels, corresponding to the shape of the blocks at each end of the pattern and the boss at the center, shown in Fig. 1. Then, by lowering the pattern over and setting it to coincide with these lines, an impression of the projecting ribs can be made, which will give a sufficient guide for cutting away to insure the pattern plate coming into close contact with the prepared bed. All the sand can be cleared away from the outside to enable the molder to bed the pattern so that the inner portion will more nearly represent the requirements of the mold. The outside can be rammed up easily when the pattern has been bedded-down properly. Bedding-in a pattern is a gradual process, but when the pattern is fragile, greater care is necessary, because that degree of hammering resorted to in stronger patterns must be avoided as much as may be possible.

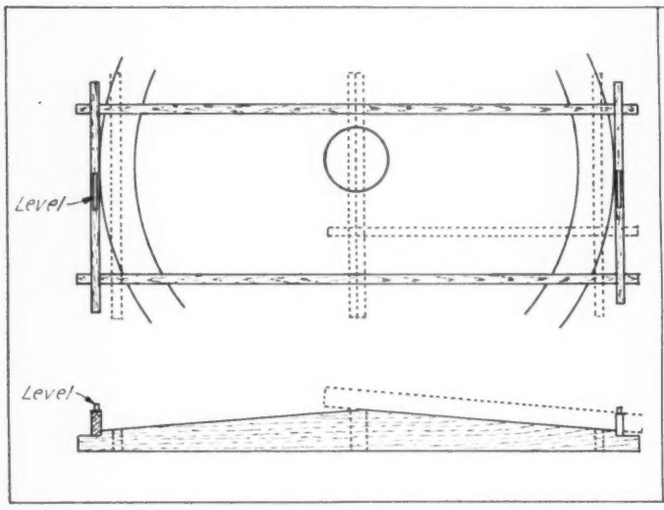


FIG. 1—PREPARING THE BED FOR MOLDING THE RUDDER YOKE

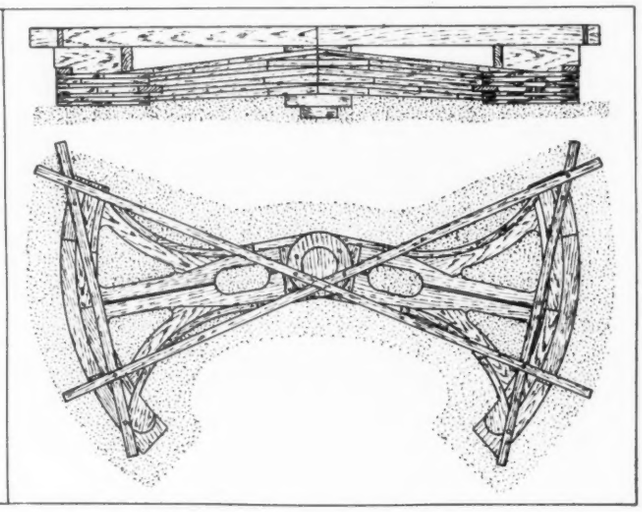


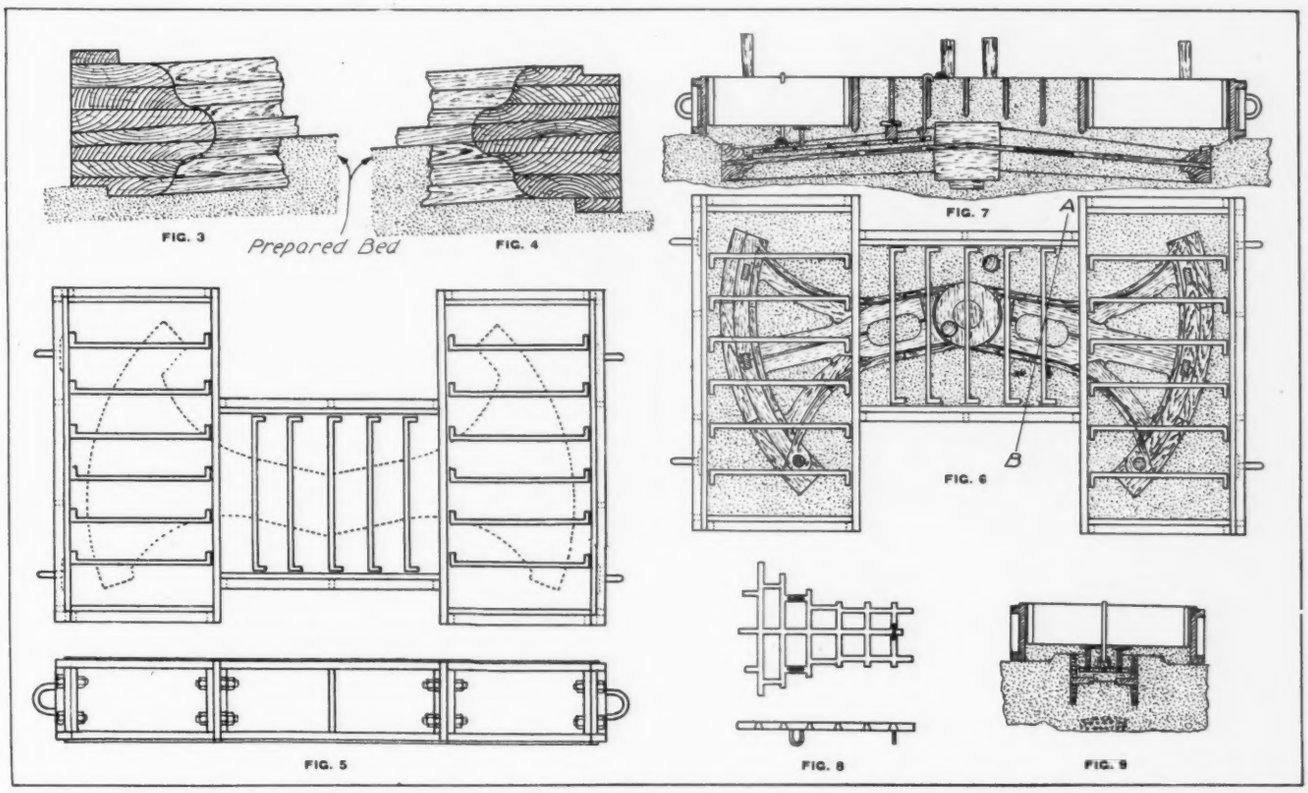
FIG. 2—ELEVATION AND PLAN OF THE PATTERN BEDDED-IN

When all the special facing sand has been applied and the pattern finally bedded down, the stiffeners on the pattern can be removed and weights lowered at suitable places on the pattern to maintain its position while the sand is being rammed around it. The lightening holes on the plate can be used to insure that the density of sand around the under side is sufficient; in any case, the bed must be broken at these places to ram up the sand to form a joint as near to the surface of the plate as possible, provided the work is to be cast in the floor. Fig. 2 is a plan of the pattern in position, having the stiffeners attached for increasing its rigidity; these successfully reduce the strain from the center of the pattern and assist the molder during the time of bedding-in. The elevation, Fig. 2, shows another view of the relation of the pattern and the stiffeners and illustrates the pattern bedded-in when the boss is the highest position and the bottom portion of the mold is made in the foundry floor. An enlarged view is shown in Fig. 3.

In providing a steel casting of this description there is much difference of opinion as to the best position for casting. The method shown in Fig. 2 is more generally followed because the gradient helps the metal when poured at the boss, but such a method provides a colder metal to the chain guides which are comparatively thin. Many molders prefer to supply the hot metal to the thinner portions when circumstances will permit, and as long as the pressure is sufficient, a good casting will result. When a drag flask is used, and it is better that one should be employed if it is convenient to do so, then the metal mold can be turned on its side and cast satisfactorily in that position. If the molder prefers casting by way of the chain guides with the bottom a fixture in the foundry floor, then the preparatory bed must be the reverse to that shown in Fig. 1, and the pattern bedded-in similar to the enlarged part view Fig. 4, with the chain guides as the highest parts of the mold so that the metal travels along the inclined plane.

When the pattern has been bedded-in and the internal portion of the mold rammed satisfactorily by making a joint up to the center of the curved edges of the lightening holes, the outside ramming can be proceeded with. With the exception of the boss, which should have about 2½ inches of special facing sand around it, a thickness of 1 to 1½-inch will suffice at all other points, so that at all parts of the mold with which the molten metal comes into contact provision must be made to secure a good casting by using the special facing sand alluded to in a previous article. Ram up the sand around the outside of the pattern and form a joint following the top of the chain guide cores, cutting it down to the thinner part for the shackle and continue the joint along the top of the ribs and the boss. Then a mean line may be taken between the surfaces of the boss and the chain guides for the cope flask and the joint is dropped to correspond with this at a distance from each side of the boss and is elevated from the chain guides to a level joint for the cope flask. The joint could be made flush with the surface of the chain guides and gradually drop from the boss to this level, but a special, deep, cover flask would be required, and the lift, if the joint is made flush with the surface of the boss would be more than is justifiable under the circumstances; hence, by taking a position approximately half of the difference between the two, an advantage is secured.

Many jobs of this character can be made satisfactorily in roll-over flasks, the principal difficulty being to provide these flasks. So many foundries have made a practice of making solid flasks and stocking them for future use, that one wonders at the lack of system which prevails. Instead of making solid flasks which do not lend themselves to any variation, it would be preferable to standardize flasks in sections, sides, ends and bars. They



FIGS. 3 AND 4—ENLARGED VIEWS OF THE ENDS OF THE PATTERN BEDDED-IN, SHOWING AN ALTERNATIVE METHOD IN FIG. 4; FIG. 5 ILLUSTRATES AN ASSEMBLED FLASK; THE COPE FLASK IN POSITION WITH GATES AND RISERS, IS SHOWN IN FIG. 6 AND FIG. 7 IS A SECTION OF THE MOLD; A GRID IS ILLUSTRATED IN FIG. 8 AND FIG. 9 IS A SECTION ON THE LINE *AB*, FIG. 6

take up much less room and flasks can be built-up in a short time to meet requirements. With a number of convenient size sides and ends in stock, flasks can be so arranged for various classes of work that little additional tackle or connecting portions are necessary. Such an example is illustrated in Fig. 5. With the exception of the connecting bars, which should be made to suit the work in hand, the flask could be formed easily from stock, and while it would be necessary to strengthen the flask when it is to be lifted, by clamping a couple of bars across, a useful flask is produced; unlike the solid flasks which has less difficulty in obtaining an impression of the bottom of the mold such as will secure more regular density to the rammed sand. When a drag flask is used for the rudder yoke, and the mold is to be filled on the flat, then a false part will be required or, as is more general and answers a similar purpose, the pattern is bedded into the previously prepared bed and a joint made similar to that shown in Fig. 4.

If it is desired to cast the mold by way of the boss, then after applying parting sand, the drag flask is lowered over in an upside down position, and with special facing sand applied about the pattern, the whole is rammed-up ing, set in the grids, lower over the cope and secure the grids to it by means of S-hooks, either directly to the top of the box bars if they are convenient, or to a bar passing over the surface of the flask bars. It is necessary to pack sand and wedge between the grids and the bottom of the flask bars to render any movement improbable.

In casting with the boss as the highest point, one of the best means of pouring the job is by supplying the molten metal to the bottom of the boss and carrying runners from the gate, shown at the side of the boss in Fig. 6 to the plate at each

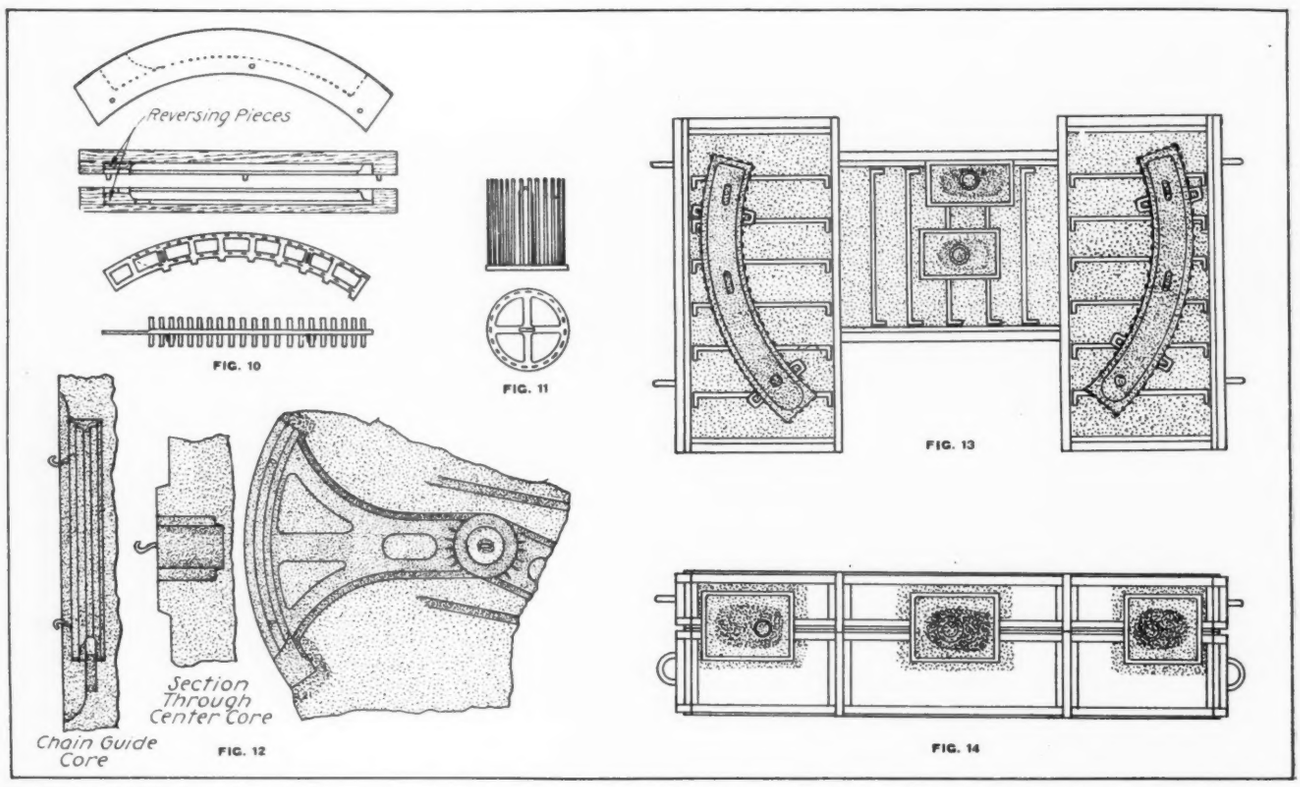


FIG. 10—CORE GRID FOR THE CHAIN GUIDE AND FIG. 11 IS A CENTER CORE GRID; PLAN OF THE DRAG WITH THE CORES SET IS SHOWN IN FIG. 12; FIG. 13 IS A PLAN VIEW OF THE MOLD SHOWING THE POURING BASINS AND READY TO CAST AND FIG. 14 SHOWS THE PREPARATION OF THE MOLD WHEN CAST ON ITS SIDE

are costly, it can be separated and returned to stock with more prospect of being useful in forming future flasks.

In steel foundries, flasks form one of the principal features of the equipment, and to run the foundry economically, just as much attention is required for this particular form of equipment as is usually applied to other forms. Sides, ends and bars can be classified and a tabulated list kept in the foreman's office, where it would be of service in determining the more suitable parts for the construction of flask parts to accommodate more of the work which comes into the average jobbing foundry. The use of the roll-over flasks gives more variation to the method of casting and the molder to the bottom of the flask. Set a number of screw-eyes into the pattern and wedge through on top of the bars to prevent any movement of the pattern when lifting; then roll over the box. Make up the joint as previously described and prepare to receive the top flask.

Fig. 6 shows the cope flask in position, but to insure a clean lift in the cope, it is better to set in flat grids between the ribs and at each side of the boss; such a grid is shown in Fig. 8, having three staples cast into it. When a drag flask is used, it is desirable that grids should be employed in both top and bottom as it is a more reliable form of strengthening the formation of the mold. Make a bedding of special loam facside. When this method is adopted it is advisable either to secure a specially prepared runner from those firms which specialize in their construction, or have one prepared in advance. It should be formed inside a block and set into the drag of the mold while ramming; the hole passing through the block is U-shaped at the bottom, one end of which comes into contact with the bottom of the boss pattern and the other and longer portion terminates at the joint of the mold. Separate pieces can be framed and set into the mold in a similar manner and connected with the main runner to form the feeders for the plate.

The connection between the hole in this block at the joint and the sur-

face of the cope can be assured by setting a gate stick, of sufficient dimensions and surrounding it in the course of ramming with special loam facing of a highly refractory nature. The same applies to the risers which are shown on the top of the boss and at three places on each of the chain guides. With the exception of the riser on the top of the boss and those on the shackle ends of the chain guides, which assist in feeding the casting at these parts, the risers shown are desirable for preventing air and gases from being imprisoned in the extremities of the mold. There is no hard and fast rule in determining the method of running a job; each design requires special consideration and successful results are obtained by different methods in districts widely separated. Experience and common sense are the main factors in solving these difficulties.

Ramming the Cope Flask

When the gates and risers have been fixed, the ramming-up of the cope flask can be proceeded with, and as there is no likelihood of contraction difficulties in this casting, hard ramming can be resorted to without fear. It is better, however, to provide a cinder bed beneath the plate at the bottom, as shown in Fig. 9, and connected with the top by the lightening holes in the plate. An elevation of the mold is shown in Fig. 7, the left side of which illustrates the mold rammed-up, and incidentally the relation between the top bars, the grid and the pattern. The section on *AB,* Fig. 6, shown by the illustration, Fig. 9, gives another view of the grid with packing pieces wedged in to make it rigid. It also represents the joint of the mold formed to equalize the lift in the cope flask.

The ramming-up completed, draw the gate sticks and lift the cope flask; if the inside of the ribs on the pattern have the necessary taper, a good lift will result; roll over the cope to be more convenient for blacking. Return to the drag and swab the sand well about the pattern to which should be attached the stretchers previously used when bedding-in. These are not so much used to safeguard the pattern, a necessary procedure, but to stiffen the pattern and thus render its withdrawal easier. The pattern, in itself lacking rigidity, would tend to bind during lifting, and an unsatisfactory result naturally would follow. Both cope and drag parts of the mold should be carefully made and slicked-off, all sharp corners rounded and a taper depression made along the joint. When sharp corners are essential, it is necessary that they should be strengthened by inserting in them a plentiful supply of brads.

At the junction between the boss and the plate or web, where the difference between the thickness of metal is so great, it is good practice to form the mold so that a number of feathers or thin ribs are cast, connecting the boss with the plate. These assist in reducing the strain caused by the unequal cooling of the metal, owing to the abrupt change in the thickness. The preparation of the mold for these feathers requires considerable care to prevent any likelihood of portions being separated by the inrush and pressure of the molten metal.

After the mold has been thoroughly slicked, and during the process, the composition forming the facing must be constantly watered because it becomes dry quickly. A mixture of fine dry composition is formed by mixing a little plumbago and water to a consistency resembling that of paint. This should be applied to the mold with a swab. Small prods are made over the mold, especially along the bottom of the chain guide, to collect any impurities which may be carried along with the metal, and also to act as pockets for any air and gas which may be confined in parts of the mold; also for those gases, notably hydrogen, which having been taken up by the metal when in a molten state, are liberated at the point of solidification. Connect the runner and risers with the mold and remove all corners formed by contact and both cope and drag can be dried.

Making the Cores

During the time occupied by the preparation of the mold, the cores required would be receiving attention. Fig. 10 shows a form of grid which is usually employed for the chain guide cores, it being simply a flat skeleton grid having a number of pieces of flat wrought iron pieces cast in, the terminal end being thinned off. Two staples are cast in, as shown, and two girls are required similar to each other except that one is right and the other left handed. Another grid is required for the center core. The one shown in Fig. 11 is suitable if a core box is supplied, but if a pinboard is used for the construction of the core, then the center bars of the grid must be omitted, but a couple of lugs can be cast on to take two staples for convenience in lifting.

The preparation of these cores is comparatively simple; they are best formed in loam composition, the two for the chain guide being vented to the outside of the core box shown in Fig. 10, care being taken to reverse the terminal ar[illegible] block after one core has been ma[illegible] fore beginning the next one. The c[illegible]ter core need only have a thickness of about 3 inches, the inside being left hollow, but precaution must be taken when closing the mold to secure a close contact between the top of the core and the cope. The cores must be dried and the two for the chain guides given a coating similar to that used for the mold, but in the case of the center core, coal tar would be preferable. Fig. 12 shows a part plan of the mold having two of the cores set in their correct relative positions, and the sections which show the joint of the mold through the center and along the chain guide cores.

Preparing the Pouring Basin

The heads or basins should next be prepared, and it is just as necessary to use care and patience on these as on the mold. Too often their preparation is hurried with consequent neglect in finishing details which may give trouble in casting. The pouring head should be large enough to supply the necessary pressure and to prevent the possibility of splashing the metal. Prepare them in strong composition, either in suitable flasks or on specially-formed plates having dabbers or prods cast on the outside, so that a receptacle can be prepared inside. These should be dried and coated with tar. When the cores have been placed in position and vents drawn off, a small amount of chalk or whiting should be placed on the top of the center core and the cope lowered into position. Drop some chalk through the runner and flow gates, and lift to make sure that the contact is right. It may be necessary to place a little clay round the top of the center core to seal it. To do this, cover it with oil, remedy any slight inaccuracy with the gates, and lower the cope into its final position. Surround the box part with a number of vents carried toward the cinder bed and prepare to cast.

Fig. 13 illustrates the heads or basins set into position when the work is cast horizontally, and a method of casting is shown in Fig. 14 when two flask parts are used. A spray is formed from the gates to supply the molten metal to the ends of the chain guides and plate, the flow gate being off the side of the boss and connected along the full length of it. In both cases they must be securely clamped or bolted before pouring the metal. Special care is necessary in the latter instance, and it is advisable to lower it into a pit and ram sand around the sides. The method adopted depends upon the general practice of the individual foundry; if the former, then one ladle containing the requisite amount of metal will suffice, if the latter, then two ladles must be used for pouring at each end.

The same procedure is adopted in preparing the metal as was described in connection with the rudder casting. It is necessary to calculate the amount of

metal required and to make a certain allowance for safety.

When all precautions have been taken to prevent any springing of the cope flask and the ladle of metal is lowered above the head, begin to pour, maintaining a steady stream of metal to provide an even pressure. When the flow gates are showing metal, the heads can be filled with the more lively metal from the ladle. If this is done expeditiously, it is possible to lift the head of metal in the main pouring basin. When the casting has become sufficiently cool for safe handling, it is removed to an annealing furnace where it is packed to maintain the correct shape. In work of this character it is necessary that the annealing should receive great consideration, as the internal strains, set up during the time of casting, render it liable to rupture. Since a rudder arm is of vital importance, every effort should be made to render such a rupture unlikely. Simply warming the casting is unavailing and useless. It should be gradually raised to a red heat and the temperature gradually reduced. It should be remembered that more care is necessary in reducing the heat to eliminate, as far as possible, all traces of strain. After annealing, steel castings are tested by drop or hammer test.

How The Foundry Aided The Machine Shop

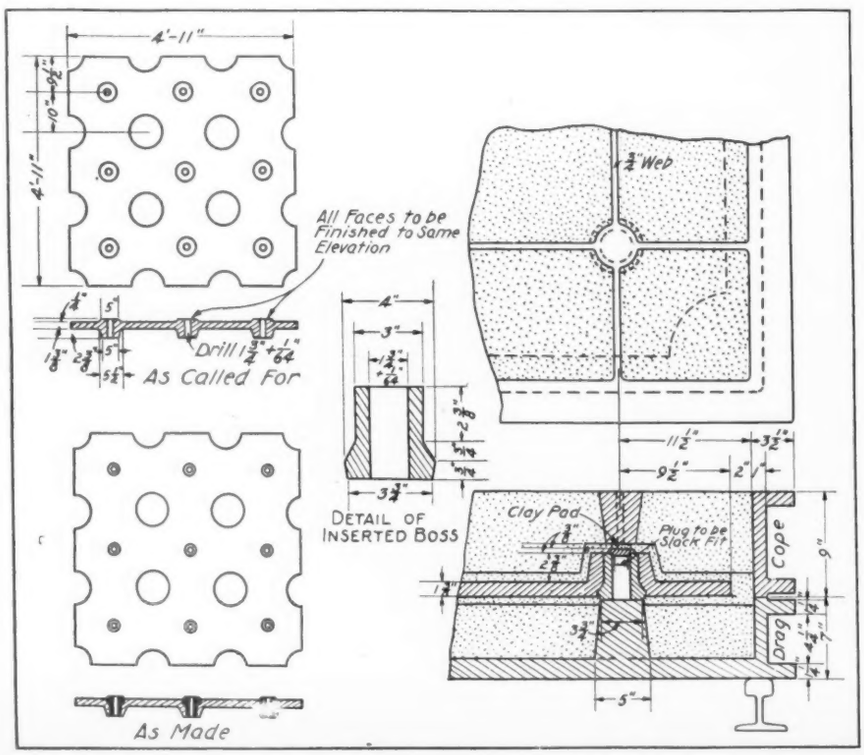
By J J McDonald

WE received an order some time ago for 300 castor plates for a plate mill now in course of construction. These plates were 4 feet 11 inches square by 1⅜ inches thick. Each plate has nine bosses equally spaced 20 inches apart. When they were ordered, these bosses were 5 inches in diameter and ¼-inch thick on the finished side. Also they had to be drilled, a 1 49/64-inch hole being required in each.

The shop superintendent found that to machine these plates in the usual way would tie up the only available planer and radial drill for two months. Besides the radial drill in question was old and could not be depended on to turn out accurate work. Under the circumstances it was decided to give the work to some outside concern. Each plate weighed 1230 pounds, or a total of 369,000 pounds for the lot. As the foundry foreman gets a bonus on the tonnage turned out, he naturally objected to the idea of sending the work out. He proposed a plan which was adopted, under which the plates were made for half the estimated cost and the machine work reduced from two men and two machines for two months to two boys and two machines for 38 days' steady work. Briefly described, the method consists in machining a set of cast-iron plugs separately, placing them in a mold and pouring the rest of the plate around them. The accompanying illustration shows the method and rigging adopted. If the holes had to be spaced accurately, of course the method would not have been satisfactory but in this case a variation in the spacing was permissible. The only really essential feature was to have the faces of the bosses the same elevation, or in other words to have them on the same horizontal plane. To insure accuracy in this respect the finished face was cast down.

Four solid flasks were made, the joints machined and pins fitted. The copes were only machined on the joints. The drags had ribs cast integrally to support nine bosses corresponding to the nine bosses on the casting. These bosses were machined across the face and were finished ¼-inch below the joint of the drag. The bottoms of the drags were also planed off true and parallel with the joints. Two rails were then set up level and the drags set on them. Since the castings did not extend into the drags, these were not disturbed until the job was finished.

In making the mold, it was only necessary to ram the drag full of sand and then scrape it off with a straight edge, clear away the sand over each of the locating plugs and set one of the prepared castings on each one. Then the sand was tucked all around and slicked off the face of the mold to form a smooth level surface. As may be noted from the illustration, the pattern was all in the cope. It was mounted on a machined cast-iron plate having pin holes in it to correspond to those in the drag. Before closing down the cope, special loose fitting plugs were set in each of the bosses and a little pinch of clay placed on each one to make sure that the cope touched, and thus preventing any movement owing to the flow of the metal while pouring. The castings were left in the molds for 12 hours. The plates came out perfect with the machined bosses true.



DETAIL OF FLASK AND RIGGING DESIGNED TO REDUCE MACHINE WORK ON CASTOR PLATES FOR A PLATE MILL

Semisteel and General Foundry Practice

Development of Standards for Melting Steel in the Cupola—Cause of Low Melting Temperature—Experiments With Vise Castings—Effect of High Blasts

By David McLain

ORIGINALLY I was a steelmaker, and had charge of the first successful crucible steel foundry and the first converter in the United States devoted to the manufacture of bessemer steel castings. Also I had charge of the first open-hearth furnace west of the Allegheny moutains.

When a boy, I believe the original idea of melting steel in the cupola was brought to mind while helping Scotty the blacksmith. Not knowing much about cast iron or steel in those days, I was just as apt to put a cast-iron rod into the fire as a steel one, and frequently had both in the fire at one time. With the bellows working hard, the steel rod generally showed signs of melting first.

About 27 years ago I had charge of a bessemer converter and learned that my predecessor allowed the gates and risers and defective steel castings to accumulate, as he did not believe steel could be melted in the cupola. We had a 7-ton converter melting 4 to 6 heats on alternate days, a tonnage of 28 to 42 tons per melt, 30 to 35 per cent of which was scrap.

A Successful Experiment

Melters and gray iron foundrymen unanimously agreed that it could not be melted in a cupola. Finally, I persuaded the melter to try some steel in the cupola the following day, which he did, without serious results, and we continued to use more and more. Before finishing the experiments, as much as 60 per cent steel was melted in the cupola. The ordinary run was from 30 to 40 per cent steel, and we made better converter steel castings by doing so.

A measure of the progress made in semisteel since that time came when the United States ordnance department specified semisteel for shells in 1918. The war ended and shells were no longer required, but a new consciousness of the importance of making good semisteel was brought home to foundrymen in America when the ordnance department requested foundrymen everywhere to submit test bars and bids covering gas and high explosive semisteel shells. While a minimum of 32,000 pounds tensile strength per square inch and an impact test looked rather stiff, hundreds began making test bars, but very few were able to actually produce shells. Because it is necessary to understand the science of mixing and melting steel scrap in cupola mixtures.

Lowering the Melting Point

When melting steel in the cupola, high carbon coke is used for fuel. When the steel comes in contact with this fuel, owing to the very low percentages of the elements in the steel, it has a strong affinity for them, particularly carbon. Consequently when the steel is heated to redness, it begins to absorb carbon, and when the steel and fuel both become incandescent, the steel become saturated with carbon. In this state it is not steel as we know it commercially, but a high carbon metal. As the carbon increases, the melting point of the steel decreases until the temperature at which it will melt is lower than the temperature of the cupola.

Personal examination has shown that 90 per cent of the cupolas are melting only 50 to 60 per cent of their capacity, although you can expect the best and hottest metal only when the cupola is operated up to its capacity. In the same way large money losses result from castings that are not gated right or perhaps the patterns have not been made to mold in the best way. Frequently by changing the bottom gates, pouring from the top instead of the bottom, we make quick savings, while at other times we find it necessary to change the construction of the patterns, core boxes, flasks and sometimes, in fact, the entire layout.

For the benefit of some who are not familiar with the manufacture of vise castings, it is well to state that there is a piece of steel cast into each jaw of the vise. It was the custom for years and probably is in many places today, when making vise castings to follow an old process in which the jaw steels were milled thoroughly, put in acid until perfectly clean and then tinned. Special fluxes were also used. There were great losses on several sizes of vises. The loss was caused by the steels not fusing with the iron, whether they were tinning the steels and using fluxes or not.

At one plant, investigation proved that by flowing sufficient metal through the mold, these steels would be fused with but small casting losses. The metal of course, must be melted very hot and the founder should be able to judge how much metal it would take to fuse the steels successfully. For instance:

A 4½-inch vise requires a steel ⅜ inch by 1 inch thick. To pour this 4½-inch vise with gates and all, 45 pounds of metal are required, without an overflow to fuse the metal. A 3½-inch vise will require the same size steel, but it will only require about 25 pounds of metal to fill the mold, and this will not fuse the steel. If the steels in the 4½-inch vise were fused, while those of the 3½-inch were not, it is evident that there was not enough metal flowing through the mold to fuse the steel.

While experimenting with steel scrap in making semisteel some 20 years ago, I found it impossible to secure satisfactory metal with high blast. The chemistry of this is similar to the oxyacetylene process of cutting steel or wrought iron.

Four Kinds of Furnaces

We learned years ago that steel was violently attacked by excessive oxygen delivered under high blast pressure in cupola melting. When steel is heated to redness by the acetylene, it will then actively combine with oxygen which oxidizes the metal along the path of the flame. It will oxidize or slag, similar to steel in the cupola under high blast, and as the slag has a lower fusing point than steel, it will run off.

There are four distinct and separate kinds of furnaces for melting steel:

Crucible .....(Acid)
Converter .....(Acid and basic)
Open-hearth ....(Acid and basic)
Electric .....(Acid and basic)

and two different processes—the acid and basic.

In America with one or two ex-

Presented at the meeting of the Southern Metal Trades association, New Orleans, May 5-6. The author, David McLain, is proprietor of McLain's System, Inc., Milwaukee.

ceptions converter steel is made by the acid process which is a straight melting proposition, while the majority of foreign converter and open-hearth steel furnaces are operated on basic, which is a refining process. The open hearth in America is both acid and basic. Crucible steel the world over, is made by the acid process.

Statistics show that previous to the war, 90 per cent of the steel castings produced in America weighed between 50 pounds and 40 tons.

Many believe that 50 to 60 per cent pig iron is required to make open-hearth steel, but this is a mistake as 15 per cent pig iron is being used with 85 per cent scrap. Small open-hearth furnaces may be operated intermittently or continuously at high temperature and with extremely fluid steel. Five 2-ton or three 5-ton heats, using 65 to 75 gallons of oil per ton of steel, can be melted in 12 hours.

The George H. Smith Steel Castings Co., Milwaukee, specialized on converter dynamo steel for 15 years. Several years ago this company installed a small open-hearth furnace. Several physical tests, taken at random, show:

Elastic limit	Tensile strength	Elongation, per cent	Contraction, per cent
49,800	88,700	....	....
50,400	90,400	21.0	24.0
48,550	97,300	22.0	29.5
50,850	93,550	21.5	27.0
46,800	87,700	22.5	31.5
44,500	81,600	25.0	37.3

Ferrosilicon in the Cupola

By H. E. Diller

Question:—We would like to know whether it would be practicable to use 15 to 25 per cent ferrosilicon in the cupola, and whether a saving in cost could be made by doing so?

Answer:—Our experience indicates that it would be entirely feasible to use 15 per cent ferrosilicon in the cupola but we have never tried to use 25 per cent ferrosilicon and could not say whether it would be practicable.

The two main objections raised against using ferrosilicon in the cupola are that there is a greater loss of silicon than when pig iron and scrap alone are used and that the composition of the iron as it comes from the cupola will have a greater variation. If there is a greater loss of silicon when using ferrosilicon it is so small that we have never been able to detect it. In melting with ferrosilicon in the mixture if the iron is left to accumulate in the cupola until a charge is melted there will be no unusual variation of silicon in the metal. Of course, in using a very high silicon iron a careless man on the cupola can do more damage in weighing the iron out incorrectly than if the metal going into the charge were all of approximately the same composition. With a reliable cupola tender and allowing the melted iron to accumulate in the cupola before tapping, uniform iron can be obtained when using 15 per cent ferrosilicon.

One advantage in having some high silicon iron in the charge is that when a new mixture is made, if the iron comes with too little or too much silicon a few pounds of ferrosilicon, taken off or added to the charge will give the right composition to the iron without a general change in the mixture. Then too if the composition of the scrap being used changes, the amount of silicon in the mixture can be corrected by the addition or subtraction of a small amount of ferrosilicon. This can be better appreciated when it is remembered that an addition of 10 pounds of 15 per cent ferrosilicon to a 1000-pound charge will raise the silicon 0.15 per cent.

Another advantage would be that a foundry making two grades of iron, say with 1.75 and 2.25 per cent silicon, could use the same general mixture for both irons by adding 70 pounds of ferrosilicon to the second mixture to bring the silicon up to the desired amount.

The question as to whether it would pay financially to use ferrosilicon might be answered with a decided *yes* in one district while in another the answer might be just as decidedly *no*. From the accompanying table it will be seen that this question would be decided by the price and quality of the scrap which would be available, as the use of ferrosilicon to replace a high-silicon pig iron with a lower silicon iron would not effect a marked saving. But if scrap were substituted for pig iron at the prices at present prevailing in the Cleveland district, on which all prices in the table are based, there would appear to be a worthwhile saving by this substitution.

Any of these mixtures would probably give good iron if properly melted, but should the sulphur in the scrab be too high or the iron be inclined to oxidation and slag enclosures, the effects of these troubles could be nullified.

NO. 1 MIXTURE—USING ALL PIG IRON WITH HOME SCRAP

	Silicon, per cent	Weight, per cent		Price per ton	Price per ton × per cent of wt.
Home scrap	*2.25 × 40 =	90.00			
Pig iron	2.00 × 25 =	50.00		$26.75	668.75
Pig iron	3.00 × 35 =	105.00		29.75	1041.25
	100	245.00			60 1710.00
Per cent silicon in mixture		*2.45		Price per ton	$28.50

NO. 2 MIXTURE—SUBSTITUTING LOW-SILICON FOR HIGH-SILICON PIG IN MIXTURE NO. 1 THROUGH THE USE OF 15 PER CENT FERROSILICON

	Silicon, per cent	Weight, per cent		Price per ton	Price per ton × per cent of wt.
Home scrap	2.25 × 40 =	90.00			
Pig iron	2.00 × 57 =	114.00		$26.75	1524.75
Ferrosilicon	15.00 × 3 =	45.00		60.00	180.00
	100	249.00			60 1704.75
Per cent silicon in mixture		2.49		Price per ton	$28.41

NO. 3 MIXTURE—SUBSTITUTING FOREIGN SCRAP FOR AS MUCH PIG IRON AS POSSIBLE IN NO. 1 MIXTURE

	Silicon, per cent	Weight, per cent		Price per ton	Price per ton × per cent of wt.
Home scrap	2.25 × 40 =	90.00			
Foreign scrap	1.75 × 20 =	35.00		$21.50	430.00
Pig iron	3.00 × 40 =	120.00		29.75	1190.00
	100	245.00			60 1620.00
Per cent silicon in mixture		2.45		Price per ton	$27.00

NO. 4 MIXTURE—SUBSTITUTING FOREIGN SCRAP FOR PIG IRON IN MIXTURE NO. 1 THROUGH THE USE OF 15 PER CENT FERROSILICON

	Silicon, per cent	Weight, per cent		Price per ton	Price per ton × per cent of wt.
Home scrap	2.25 × 40 =	90.00			
Foreign scrap	1.75 × 56 =	98.00		$21.50	1204.00
Ferrosilicon	15.00 × 4 =	60.00		60.00	240.00
	100	248.00			60 1444.00
		2.48			$24.07
			Six pounds	ferromanganese	.36
				Price per ton	$24.43

*Silicon in home scrap is figured 0.20 per cent below the amount of silicon in the mixture to allow for loss in the cupola.

Metallography Applied to Nonferrous Metals—VI

Alloys of Nickel with Copper and With Other Metals are Considered and Analyzed —Information is Offered Concerning the Commercial Advantages of Different Series

By Ernest J Davis

NICKEL is one of the comparatively rare metals, which has only in the last few years come into general use. Its field of usefulness has largely increased of late, as its cost has been reduced by the discovery of new sources of supply, and improvements in methods of production. It is white in color, malleable and ductile. In its properties it closely resembles iron, but it does not rust on exposure to moist air. Apart from the noble metals, it is the most stable metal in use. Nickel melts at about 1450 degrees Cent., but does not cast well, as it absorbs carbon monoxide, which is given off on cooling, causing holes and honeycombing in the castings. This disadvantage is overcome by the addition of a small quantity of magnesium. The amount originally added by Fleitman, who discovered its action was ⅛ per cent, but

FIG. 1—MICROGRAPH ILLUSTRATING THE CORED STRUCTURE OF CUPRO-NICKEL. MAGNIFIED 100 DIAMETERS

much less is frequently used. The magnesium seems to have much the same effect as does aluminum when added to steel. A small quantity of magnesium is always left in the metal, but is usually overlooked in analysis as it is somewhat difficult to estimate. Aluminum or phosphorus have been suggested for use in the place of magnesium.

The most important series of nickel alloys are those of copper. Nickel and copper alloy readily in all proportions forming a continuous series of solid solutions. The equilibrium diagram for the nickel-copper series is given in Fig. 2. From the freezing point curves of this series of alloys, as determined by Gautier, it would seem that a compound corresponding to the formula CuNi is formed, which is soluble in both copper and nickel. The micro-

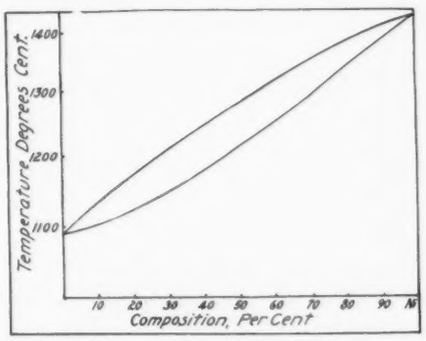


FIG. 2 — EQUILIBRIUM DIAGRAM FOR THE NICKEL-COPPER SERIES OF SOLID SOLUTION

structure of the alloys confirms the view that they are solid solutions, but does not indicate the existence of a compound. The electrical conductivity of the series, however, shows a minimum in the alloys containing about 40 per cent of nickel, which is not far removed from the composition of the supposed compound; but on the other hand, the measurement of the electromotive force of the alloys fails to indicate the existence of any such compound. Both the liquidus and solidus are slightly curved lines joining the freezing points of the two pure metals. The exact temperatures are still a matter of doubt, but the general slope of the curves is probably correct. In all the alloys the crystals which separate first are richer in nickel than those which crystallize later, so that if cooling is moderately rapid there is a gradual decrease in the proportion of nickel from the center of each crystal grain to the outside, and a cored appearance is found on polishing and etching and examination under the microscope.

Fig. 1 is a micrograph showing the cored structure of a "cupro-nickel," as copper-nickel alloys are named, at a magnification of 100. The difference in composition from the center to the outside of the crystal grains increases as the percentage of nickel increases, reaching a maximum at about 50 per cent of nickel and then gradually decreases again. Equilibrium conditions are attained only after a period of annealing; the composition then becomes uniform, and a section shows a simple polygon structure similar to that of a pure metal. Apart from the alloy containing 50 per cent of nickel which is used in the manufacture of nickel-silver, the alloys most generally used contain quantities of nickel not exceeding 25 per cent. The nickel-copper alloys are used for a variety of purposes. Those containing 2 to 3 per cent of nickel have been substituted for pure copper in locomotive fireboxes, a similar alloy has also been used for locomotive fire-box plates. Alloys containing 12 to 25 per cent of nickel are employed for the manufacture of coins. The former alloy is used in the United States and the latter in Germany.

A 40 per cent alloy of nickel is largely used in conjunction with wire for electrical resistances and also in

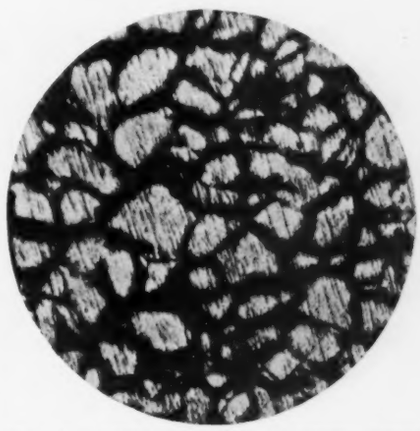


FIG. 3 — MICROSTRUCTURE OF MONEL METAL WHEN IN EQUILIBRIUM—MAGNIFIED 100 DIAMETERS

conjunction with a copper wire as a thermo-electric junction suitable for measurement of temperatures which are not sufficiently high to require a platinum couple. An alloy containing 20 per cent of nickel is largely used for tips on rifle bullets on account of the noncorrodibility of this alloy. During the last few years an alloy of nickel and copper called monel metal has been found quite useful for articles where strength and noncorrodibility are essential. This alloy is produced by the direct reduction of a nickel-copper matte obtained by smelting mixed sulphide ores of these metals as they occur in Ontario, Canada. Naturally the compo-

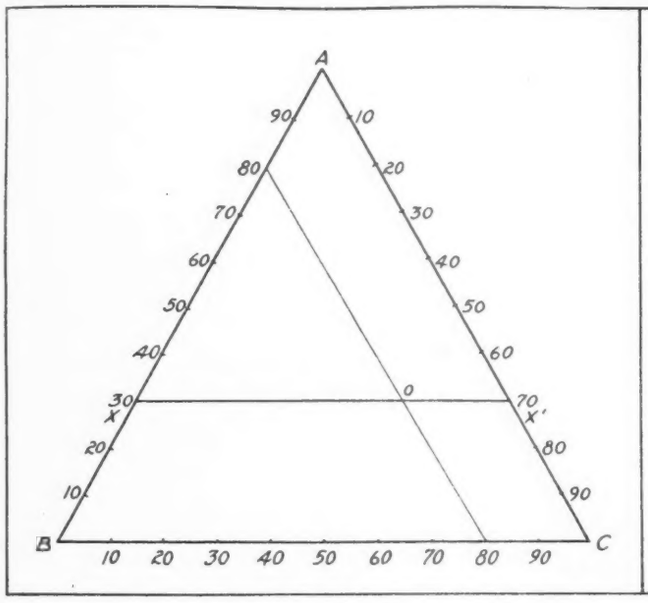


FIG. 4—TERNARY DIAGRAM OF PURE METALS, EACH CORNER REPRESENTING ONE METAL

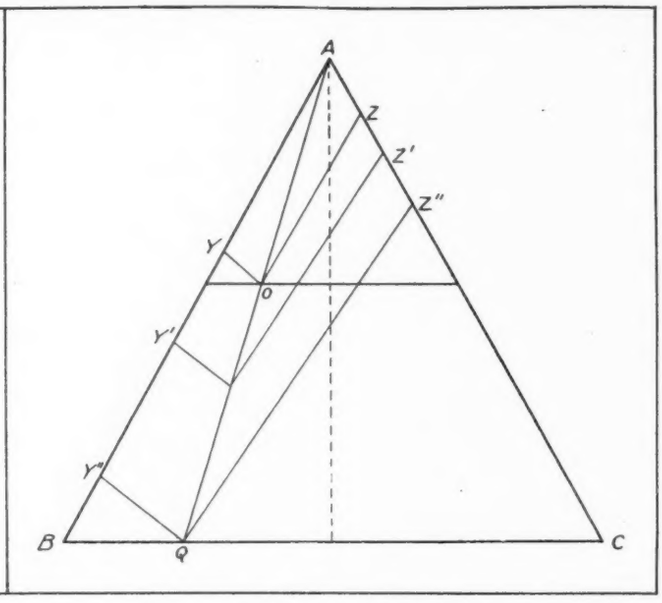


FIG. 5—DIAGRAM IN WHICH PERCENTAGE COMPOSITION OF METALS IS CONSIDERED

sition varies and additions of either copper or nickel may be made to alter the mechanical properties to suit requirements. The composition of the natural alloy approximates to 67 per cent nickel, 28 per cent copper, 2 to 3 per cent iron, and small quantities of silicon, manganese, etc. When properly rolled such an alloy has a tensile strength of 105,000 pounds per square inch, an elastic limit of 76,000 pounds per square inch and 20 per cent elongation in 2 inches. The alloy casts well if a suitable deoxidizer such as aluminum or magnesium is used. It may be rolled into rods or sheets without difficulty. It resists corrosion remarkably well and is used on this account for articles where noncorrodibility is an advantage. The microstructure of monel metal when in equilibrium is that of a homogeneous solid solution and is illustrated in Fig. 3, at a magnification of 100 diameters.

Probably the most important alloy of nickel is that with iron which constitutes nickel-steel, but iron alloys are not considered here. The accompanying table gives some compositions of the cupro-nickel alloys together with their uses.

Composition			
Copper	Nickel	Iron	Used for
98	2	..	Tubes for locomotive boilers.
95	5	..	Projectile bands.
90	10	..	Electrical resistances.
85	15	..	Rifle ammunition. Solid Drawn Tubes.
80	20	..	Plumbers fittings to resist corrosion.
75	25	..	Coinage.
70	30	..	Electrical resistance in form of tape or wire.
28	70	2	Monel metal.

A more complex series of nickel alloys is made up of copper, nickel and zinc. Before discussing the equilibrium diagram of this series of alloys an explanation of the ternary diagrams in general will be given. Ternary alloys, i. e., alloys of three metals, are more complex than those which contain only two, and few series of ternary alloys have been studied with any degree of completeness. For graphic representation of the equilibrium conditions of systems of three components the most simple method is that in which an equilibrium triangle is used for showing the composition of the various mixtures. Each corner of the triangle, Fig. 4, represents one of the pure metals, in this case, *A*, *B* or *C* point on any side of the triangle represents a mixture of the metals *A* with *B*, *B* with *C*, or *C* with *A*, in a proportion given by the scale of composition attached. Any point within the triangle indicates a mixture of all three metals. Suppose a point is required to represent an alloy containing 30 per cent of *A*, 20 per cent of *B* and 50 per cent of *C*. Along the side *A B*, Fig. 4, which represents mixtures of *A* and *B*, the length *B-X* is set out to correspond to the proportion of *A*, and the length *A Y* with the proportion of *B*; or *B X* is 30 per cent, and *A Y* is 20 per cent of the length *A B*. The percentage of the

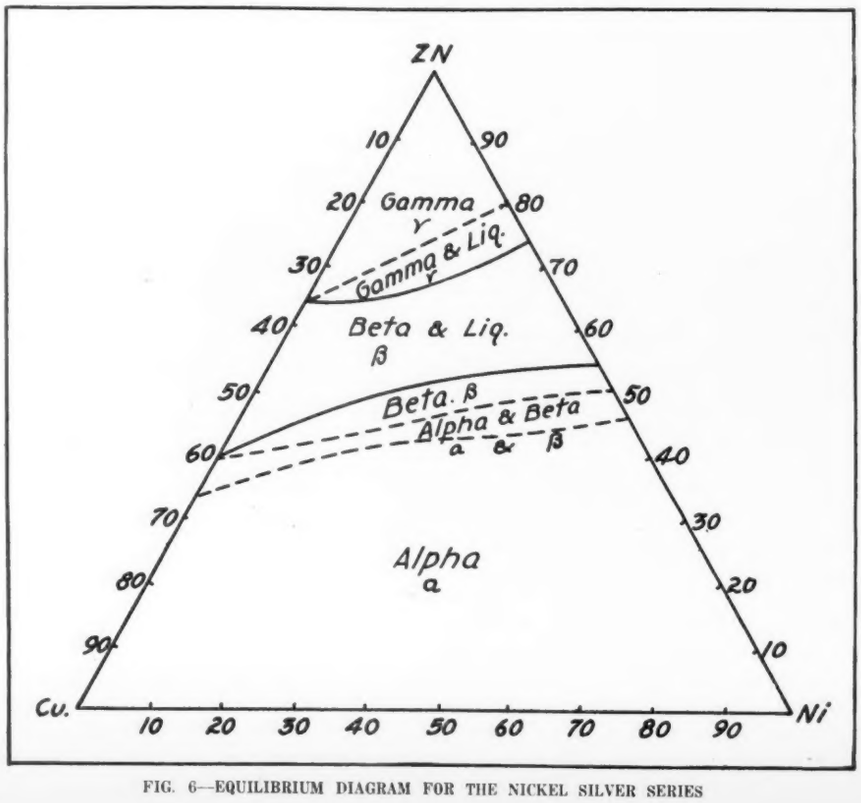


FIG. 6—EQUILIBRIUM DIAGRAM FOR THE NICKEL SILVER SERIES

third metal, C, is then shown by the length, $X\ Y$, on the diagram since the sum of the three is equal to 100 per cent of the mixture. Through X a line is drawn parallel to $B\ C$ and through Y a line is drawn to $A\ C$; these two lines intersect at O the point required. It will be seen that the method of determining O admits of considerable variation. A useful property of this form of diagram is that all the points which are in a line drawn from one corner, such as A, Fig. 5, to any point, Q, on the opposite side represent mixtures in which the relative proportions of the two component metals are the same; for the ratio of B to C in the mixtures indicated by the points O, P and Q is $\frac{AY}{AZ}$, $\frac{AY'}{AZ'}$, $\frac{AY''}{AZ''}$, respectively and the same line $A\ Q$ is useful for indicating the percentage composition of only two of the components in a mixture which contains three metals.

Thus, for a mixture representing the point O, the relative proportions of B and C to each other are given by the lengths $C\ Q$ and $B\ Q$ and can be read off directly as percentages if a suitable scale be applied to $B\ C$. The percentage of B and C in the whole mixture is given by the lengths $N\ O$ and $M\ O$, respectively. Such as the diagram, Fig. 5, above described, only takes into account the percentage composition of ternary alloys. To complete the diagram for equilibrium conditions account must be taken of the temperature. For this purpose a solid figure bounded at the sides by an irregular surface, is used. Perpendiculars proportional in length to the temperatures

FIG. 7—MICROGRAPH OF NICKEL-SILVER CONTAINING 53.3 PER CENT COPPER, 26.6 PER CENT ZINC AND 20 PER CENT NICKEL

of the freezing points of the several mixtures are raised from various points on the base of an equateral triangle, the lines are then joined up and a solid model, the top of which is an irregular surface, is formed.

The constituents occurring in a ternary system are the same as may occur in a binary system, viz., a pure metal, solid solution or chemical compound, a binary eutectic and a ternary eutectic. A eutectic consists of all three metals. A cooling curve of such a system would therefore show three arrests or critical points; the first corresponding to the separation of a pure metal, solid solution or chemical compound, the second to the formation of a binary eutectic, and the third to the formation of the ternary eutectic which only occurs in the lowest melting alloy.

The alloys of the copper-zinc-nickel series are more commonly known as nickel-silvers and sometimes as argentan, packfong, electrum, etc. They are white in color and vary widely in composition and are very ductile. The nickel-silvers are made in an almost endless variety of qualities, the most usual composition being 55 to 60 per cent of

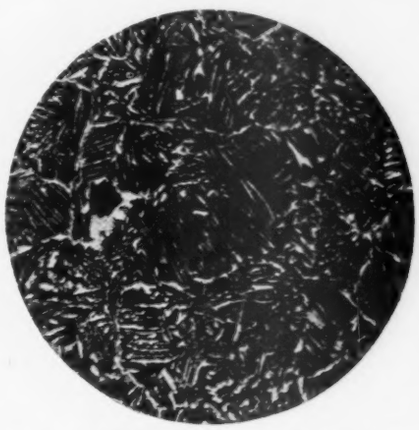


FIG. 8 — MICROGRAPH OF ALLOY CONTAINING 43.3 PER CENT COPPER, 48.8 PER CENT ZINC AND 8.16 PER CENT NICKEL

copper, 15 to 20 per cent of nickel and 20 to 30 per cent of zinc.

From the equilibrium diagram, Fig. 6, it will be seen that no ternary compounds are formed, but a number of solid solutions are formed as might be expected from a consideration of the copper-nickel and copper-zinc diagrams already studied. The liquidus and solidus have been determined with fair completeness, except in the region of mixtures containing more than 70 per cent of zinc; but the changes in the solid alloys, particularly toward the zinc corner of the series have only been imperfectly investigated. In the equilibrium diagram, Fig. 6, both the liquidus and solidus are shown. The phase boundries of the liquidus surface are full lines, and those of the solidus are dotted lines. The ternary liquidus and solidus diagrams for this series have been drawn separately, but are not included in this article.

Reviewing the three systems of which nickel-silver is composed we see that alloys of copper and nickel are soluble in each other in all proportions; copper and zinc form several solid solutions, the alpha and beta solutions being particularly important. The alloys of nickel and zinc also form solid solutions of which those denoted by alpha and beta only need be considered. There is also

FIG. 9—BETA ALLOY CONTAINING 27.0 PER CENT COPPER, 52.8 PER CENT ZINC AND 20.2 PER CENT NICKEL

a compound having the formula $NiZn_3$ which is capable of forming a solid solution with excess of zinc and with the beta solution a eutectic is formed. The ternary phases obtained by a combination of the above systems are lettered in accordance with the binary systems. Thus we have a ternary alpha solid solution which varies continuously from the alpha solution of the copper-zinc to the alpha solution of the nickel-zinc series; the copper and nickel may be interchanged with but small alteration in the limiting proportion of zinc. Similar remarks apply to the ternary beta solution. Between the pure alpha and pure beta phases there is a narrow space within which mixtures of the two phases are stable, the micro-structure then being duplex. The boundaries of these three phases vary with the temperature but the data for these limitations are far from complete. A binary eutectic occurs in the copper-nickel-zinc series and is shown as a broken line near the top of the equilibrium diagram, Fig. 6. The technically important alloys, as will be seen from the diagram, belong to the extreme end of the diagram. In this case they contain only the alpha phase. An examination of the commercial nickel-silvers shows the characteristic cored structure which is already familiar in the copper-zinc and copper-nickel alloys. Fig. 7 is a micrograph of an alpha nickel-silver containing 53.3 per cent copper, 26 per cent zinc and 20 per cent nickel, at 100 diameters magnification showing the well-marked cores.

The coring of the copper-zinc-nickel alloys is difficult to remove even after long annealing. In fact faint traces of the cores were seen even after

annealing 72 hours at a temperature of 700 degrees Cent. The extreme slowness of diffusion in the alpha nickel silvers as compared with the corresponding alpha solution of the copper-zinc alloys is caused by the presence of nickel. The same extreme slowness of diffusion is noticed in alloys of copper and nickel such as cupro-nickel and is probably connected with the wide difference in the melting points of copper and nickel. Fig. 8 is a micrograph of an alloy of 43.3 per cent copper, 48.8 per cent zinc and 8.16 per cent nickel magnified 100 diameters. This shows the duplex structure of the alpha-beta solid solutions, the alpha being white in the micrograph. An example of the beta alloy is illustrated by a composition of copper 27 per cent, zinc 52.8 per cent and nickel 20.2 per cent and is shown in Fig. 9 under the same magnification. Nickel-silver is of course more expensive than brass and is considerably more difficult to prepare and cast in the foundry. The properties which make it so valuable are its white color, tenacity, toughness, malleability, ductility and most of all its power of resisting certain chemical influences.

When carefully prepared, nickel-silver works well under the stamps and between the rolls and can readily be drawn into wire It is advisable that the metals used in alloying should be as pure as possible, since small quantities of certain impurities, such as arsenic, seriously injure its working qualities. Cobalt frequently accompanies nickel in the native ores, and becomes reduced at the same time as nickel. It alloys readily with it, but as the chemical and physical properties of both metals are closely allied to each other, cobalt does not exert an injurious influence in the nickel silvers. Iron has a beneficial effect. It makes the nickel silver whiter, increases the tenacity and elasticity, but makes the alloy harder. For the better class of nickel silver, the alloy is probably best without the presence of iron. According to Hiorns, the iron remains dissolved in the solid solution and therefore cannot affect the microstructure. Tin is more injurious than iron, with 2 to 4 per cent of tin the alloys were found to be brittle when rolled and the metal had a yellow color.

In some mixtures silver is added; but in certain proportions it does not impair the malleability. However, no particular advantage is gained by its use, especially as it makes the alloy more expensive. The following table gives analyses of different makes of nickel silver from Hiorns "Mixed Metals:"

	No. 1	No. 2	No. 3
Copper	66.0	59.2	55.0
Nickel	8.2	16.0	20.7
Zinc	25.3	23.8	23.3
Iron	0.5	1.0	1.0

Platinoid is an alloy of the nickel-silver type and has a low electrical conductivity; it contains tungsten and its composition is about 60 per cent copper, 14 per cent nickel, 24 per cent zinc and from 1 to 2 per cent tungsten. This alloy has largely been used in the manufacture of electrical resistances. It should be noted, however, that many samples of platinoid fail to show even a trace of tungsten. The microstructure of such an alloy consists wholly of alpha solid solution and would show the characteristic cored formation.

Nickel silver containing aluminum has also been suggested. The aluminum acts more or less as a deoxidizer. An alloy containing 57 per cent copper, 20 per cent zinc and 20 per cent nickel with 3 per cent aluminum is largely used for typewriter parts. Magnesium also has been used for the same purpose but the high cost of these alloys has prevented their general application.

Foundry Adds Furnace

The Allied Steel Castings Co., Harvey, Ill., which is controlled by the Chicago Malleable Castings Co. and the Universal Draft Gear Attachment Co., Chicago, plans to install a 10-ton open-hearth furnace. This unit will supplement the present Wellman-Seaver-Morgan 5-ton tilting furnace which will be enlarged.

Manganese Bronze Made From Scrap Metals

In a paper read at a recent meeting of the American Institute of Mining Engineers, P. E. McKinney, chemist and metallurgist of the naval gun factory, United States navy yard, Washington, D. C., describes a process for making manganese-bronze from scrap metals. This process has been in operation for more than three years and has produced a metal having a fine, uniform fracture with a tendency to a silky grain, in many cases. The results of six tensile tests are given. The ultimate strength in these tests ranges from 66,400 to 72,600 pounds per square inch, the yield point from 33,900 to 45,800 pounds per square inch, and the elongation from 23.4 to 30.9 per cent.

The composition of the average manganese bronze which contains a total 0.25 to 1 per cent of iron, manganese, aluminum and tin, and from 0.10 to 0.50 per cent of lead is said to show rather clearly that there is no necessity for the use of high-grade raw material, provided methods of manufacture can be devised.

Manganese-bronze castings have been successfully made in the reverberatory furnace using scrap metal, but the crucible furnace has not proved satisfactory for this purpose. A typical charge consists of:

	Pounds
Yellow-brass machine-shop turnings	1250
Zinc dross from galvanizing plant	400
Aluminum turnings	30
Recovered scrap zinc	400
Dross and skimmings from billet and slab plant	2000
Foundry-floor scrap and skimmings	650
Hardener made by melting scrap copper and manganese in equal proportions	250
Charcoal	75
Common salt	80

In charging the furnace the hardener is placed on the bottom and on top of it the dross, with a layer of charcoal, after which the foundry skimmings and turnings are added. When the bath is melted the aluminum scrap is charged and the necessary zinc additions are made.

Book Review

The Science of Management, by Frederick A. Parkhurst, M. E.; cloth; 203 pages, 6 x 9 inches; published by the author and furnished by THE FOUNDRY for $3 net.

Mr. Parkhurst is the author of several works on scientific management, particularly as applied to machine shops and foundries. Sections 10 to 17 from "Scientific Management in the Foundry," a paper read at the 1914 convention of the American Foundrymen's association in Chicago, are incorporated in the present work. This book was prepared originally as a text for the students at the Case School of Applied Science, Cleveland. It contains the necessary chapters from the various books on the allied integral parts of the subject.

The science of management is treated of both comprehensively and in detail, and illustrated with numerous typical standard production sheets.

Beginning with a history of the science of management, the book treats successively of every stage of procedure necessary to establish the system in any plant or business. It may be roughly divided into four sections and each section is treated with a wealth of detail. Chapters 1 to 13 inclusive deal with the duties and scope of activities of the different employes. Chapters 14 to 21 are concerned with stores, labor and costs, in general and in detail. Chapters 22 to 28 show how time study and bonuses may be worked out to suit various conditions; and chapters 29 and 30 deal with inspection and the effect of scientific management on the cost and quality of the manufactured product; and also the effect on the management and employes.

H. Harrison Kress formerly in the main office of the Hauck Mfg. Co., Brooklyn, has been appointed district manager for the Hauck burner service station at Philadelphia. This station recently was removed from 1711 Sansom street to 1718 Sansom street.

Characteristics of Aluminum and Its Alloys

Bureau of Standards Has Just Completed Exhaustive Investigation Some Details of Which Are Abstracted in This Article

AN exceedingly interesting circular on aluminum and its light alloys has recently been issued by the bureau of standards, Washington, from which the following abstract has been prepared. The metal aluminum constitutes approximately 7 per cent of the crust of the earth. It exists in clays, in feldspar and other silicates, but for manufacturing purposes only two relatively rare minerals are used, namely bauxite and cryolite. The former is found at Baux in France, from which deposit it derives its name, also at Hessen-Nassau in Germany; in Ireland, and in the state of Arkansas. Cryolite is found at Ivitut in Greenland. The production of the metal necessitates two operations; one the purification of the ores and the other the electrolysis of the aluminum. The ores contain from 1 to 30 per cent of iron and silicon, which if not removed would be reduced and enter the aluminum.

The metal is produced in carbon-lined pots approximately 3 feet wide, 3 feet deep and 6 feet long. The carbon lining of the pot forms the cathode and the electrodes, which are carbon blocks, form the anodes. The temperature of the furnaces ranges from 900 to 1000 degrees Cent., or 1652 to 1832 degrees Fahr. The heating of the pot or furnace is done by the electric current and approximately 30 kilowatt hours are required to produce 1 kilogram, or 2.2 pounds of aluminum.

The process is continuous and the molten aluminum is tapped every 24 hours into small ladles which are emptied into one large mixing ladle, from which it is cast into ingots. There are two commercial grades of aluminum made in the United States: Grade A contains 99 per cent or more of aluminum, used for rolling, stamping and for the production of light alloys. Grade B is also sometimes used for casting purposes, and as a deoxidizer for steel. The impurities in aluminum are principally iron and silicon, sometimes also traces of copper and sodium are found. In Grade A, the silicon varies from 0.15 to 0.40 per cent, and the iron from 0.25 to 0.70 per cent; copper from a trace to 0.05 per cent, and sodium only a trace. Grade B contains more iron and silicon.

Aluminum is marketed in the form of "waffle" ingots; a series of square plaques, 3 x 3 x ¾ inches, connected by a thin web, or as notched-bar ingots, about 14 inches long by 1¼ inches wide. For rolling purposes there are different sizes of ingots as follows: 3½ x 12 x 24 inches; 3 x 12 x 32 inches; 2 x 12 x 20 inches, and 1⅜ x 12 x 18 inches.

Aluminum is readily stamped, drawn, and spun. The oxyacetylene or oxygas torch is usually used in welding aluminum, either sheet or cast and the welds are often so perfect they cannot be detected in the finished article. The process requires experience, and welders familiar with iron and steel, generally make failures on trying aluminum.

It is sometimes advisable to solder aluminum in which case the solder is best applied without a flux. The edges of the aluminum must be filed clean, and tinned with the solder, which should be thoroughly rubbed into the surface with a wire brush or with waste. The joint is then readily made in the usual manner between the tinned surfaces using an iron if necessary. To protect the joint from moisture which would cause disintegration, it should be coated with a varnish.

Casting Temperature

Several finishes are given to aluminum. The two most important are the polished and the satin finish. The polished finish is obtained in the usual manner by buffing with rouge, the satin finish is obtained by two methods, by caustic dipping, or by scratch brushing. To satin finish by caustic, the metal is first cleaned in benzine, then dipped in boiling concentrated caustic soda; then is washed and dipped in strong hot, nitric acid, and afterwards washed in boiling water, then is dried very quickly. The scratch brush finish is produced by carefully freeing the metal from grease then brushing on a wire brush wheel.

Pure aluminum is rarely used for castings, because of its softness, high shrinkage, and poor machining qualities. It produces excellent alloys with copper, zinc, magnesium or combinations of these metals, and when melted with proper care fine castings are obtained.

In general the casting practice for aluminum alloys follows that for brasses and bronze. The alloys may be melted in graphite crucibles in either oil, gas, coke or coal-fired furnaces. Electric furnaces of suitable types also may be used. Care is necessary not to overheat the metal, as it then oxidizes, absorbs gases, and may at higher temperatures absorb carbon and silicon from the crucible. Good practice favors keeping the temperature of the metal during melting down practically at its melting point by the continuous addition of solid metal. Pouring should be done at the lowest temperature at which the mold will be completely filled. A temperature of 700 degrees Cent. or below is satisfactory. A low-pouring temperature is especially important for aluminum alloys because of their high specific heat. If poured at a high temperature, the metal in cooling heats the mold so hot that the rate at which the casting cools is very slow. A coarse grain and weak metal will result.

No flux should be used in melting down and the surface should not be covered with carbon, as this may be included in the casting. Just before pouring, however, a small amount of zinc chloride may be added with advantage. This thoroughly cleans the surface and prevents dross from entering the casting.

Two characteristics of the metal influence the production of good castings. First, the metal or its alloys are quite brittle or hot short at temperatures just below the melting point, and secondly they are light, or of low specific gravity. The first characteristic makes it necessary to have soft and yielding cores and molds, which means that green sand should be used whenever possible and hard ramming avoided.

The mold should be poured carefully and not too rapidly, as the metal may otherwise fail to fill it completely. The casting should be stripped as soon as set to prevent its cracking. For ordinary brass foundry alloys, the patternmaker's allowance for shrinkage is 0.156 inch per foot; for aluminum the shrinkage allowance is 0.203 inch per foot.

Probably 95 per cent of the aluminum castings made in this country are from the No. 12 alloy, consisting of aluminum 92 per cent, and copper, 8 per cent. This alloy has a melting range of 637 to 540 degrees Cent., a shrinkage of 0.156 inch per foot; a tensile strength, when properly melted, of 18,000 pounds per square inch; an elongation of 1.5 per cent, and specific gravity, 2.89.

Aluminum alloys are also used containing from 8.5 to 14 per cent copper. These alloys are used for castings which are to be subjected to high temperatures, such as manifolds, pistons, and also for castings to withstand pressure, such as pumps. The 8.5 to 11 per cent copper alloy is generally used for pistons and the 11 to 14 per cent copper alloy is used for pressure castings.

Of the copper-zinc-aluminum alloys, No. 31, consisting of aluminum, 82 per

cent; copper, 3 per cent, and zinc, 15 per cent, is extensively used abroad. This alloy has more tensile strength than No. 12; usually from 22,000 to 25,000 pounds per square inch. One of the earliest commercial aluminum alloys is magnalium, which originally contained from 5 to 30 per cent magnesium, and also small quantities of copper and nickel. This alloy can be depended upon to have around 20,000 pounds per square inch tensile strength, with from 0.5 to 0.2 per cent elongation. With care a tensile of 25,000 pounds per square inch may be obtained with 5 per cent elongation.

Another aluminum-zinc alloy used for general castings contains 35 per cent of zinc, the remainder being aluminum. This alloy has a melting range from 585 to 440 degrees Cent.; a shrinkage of 0.156 inch per foot; a specific gravity of 3.32, and a tensile strength of 35,000 pounds per square inch, but it has little or no ductility. Alloys of aluminum, manganese and copper also find some application. These may contain from 1 to 2 per cent copper, 1 per cent manganese and the balance aluminum. They have a tensile strength of about 18,000 pounds per square inch, with 8 per cent elongation in 2 inches and their specific gravity will be 2.80.

HOW AND WHY IN BRASS FOUNDING

By Charles Vickers

Chills in Brass Handles

We have experienced considerable trouble in casting brass automobile handles. The handles have an iron chill cast in them and the metal blows off the chills, although we dip them in oil. As we have a large order for these castings we would greatly appreciate any suggestions you may be able to offer concerning the cause of our difficulty.

Oil usually causes chills to blow. The surest way to prevent blowing is to leave the molds open until just before pouring time, then if the chills are large enough to have them hot enough for water to sizzle when dropped onto them. Pour before the chills cool. In the case of small chills they are placed in the mold and the latter is left open, and a little before pouring time the chill is heated with a gasoline torch. In this case the part of the mold surrounding the chill will have to be faced with a sand containing a binder such as silicate of soda, or molasses, otherwise it may burn and crumble away. If the shape of the steel is such that the metal will grip it and hold it firmly even if it is not in intimate contact with the brass, a good way to prevent blowing is to make cores out of the chills, by dipping them in linseed oil compound, and while oiled to dip them into very fine dry sand. The sand will adhere and the chills should then be baked like an oil sand core. So treated, chills never blow. Almost every foundryman has his own especial way of preventing chills blowing with the result there are many different ways. One foundryman oils them thinly with a paste of linseed oil and plumbago, then bakes them; another thins shellac with wood alcohol, then adds plumbago, making a batter that will leave a thin coating when the chills are dipped and then dries them. If the coating is not thick enough the chills are redipped. In all cases the chills should be free from rust or scale, even the scale produced when steel is blued will cause blowing, and it frequently happens that if the steel, or iron, is perfectly clean and bright, and especially if it is the coppered and polished variety, that the chills can be placed in the mold as the latter are made and closed as for cores, and the chills never blow. Molds containing chills should be poured off with sufficient frequency to avoid their standing any great length of time, because this allows moisture to condense on the chill and cause rusting, which will produce a blow.

Preparing Steel Molds for Brass Casting

We expect to cast brass castings in steel molds and would like to know with what material the molds should be coated to protect them against pitting and that will insure smooth castings.

The only coating to apply to a steel mold for molten brass is plumbago. It must be applied dry, rubbed-on and polished. The best way to coat with plumbago is to use a piece of a plumbago crucible and rub the mold with this until coated. To insure smooth castings, add aluminum to the brass, about 0.25 per cent as a minimum. If the brass contains zinc, it will be difficult to cast. If a red brass mixture is used, the castings will crack before they can be removed from the mold. The foregoing remarks apply to the die-casting of brass and composition. If the castings are flat cakes cast in open molds, or if they are rods to be cast in long, iron molds from an alloy containing copper, 60 per cent; zinc, 38 per cent and lead, 2 per cent; it will be necessary to add a small amount of aluminum to the brass. The steel mold should be coated with lard oil, but it should not be applied so thickly that it will run over the surface.

Fluxes to Replace Zinc Chloride for Melting Aluminum

We are melting a large amount of scrap aluminum which appears to contain considerable dirt. We have been using chloride of zinc, but we are unable to purchase any more of this chemical and we are at a loss to know just what to substitute. Any suggestions you may be able to offer will be appreciated.

There is really no reason why chloride of zinc should be difficult to procure even in war times, as it is essential to the successful melting and casting of aluminum. Probably as a result of this shortage the manufacturers of this chemical will find it difficult to recover the market as substitutes are easily obtainable.

Before considering substitutes, a method will be outlined that permits of the use of chloride of zinc, even if it cannot be obtained. It will be necessary to have recourse to the time-honored methods of the tinsmith and the plumber. Purchase some muriatic acid, the commercial yellowish acid is pure enough, but if any difficulty is experienced the better grade acid used by photographers can be used. Place the acid in an earthen vessel and add as much zinc as the acid will cut. Cover the jar to retain the steam and leave plenty of space above the liquid so that it will not boil over the sides of the vessel. When the action has ceased, the fluid will be an aqueous solution of chloride of zinc, and to make it easy to use on metals, mix it with fine dry sawdust, or with powdered charcoal. Keep the mixture in a covered metal container. This will produce the same results as the regular fused chloride of zinc and will be found even more satisfactory as it spreads out on the surface of the

aluminum much better and freer.

Regarding substitutes, salt is sometimes used, but barium chloride is better. The advantage of using the latter substance is that it does not have the same effect as zinc chloride in promoting the formation of nitride. Calcium chloride also can be used, as well as magnesium chloride, but these latter chemicals have the disadvantage of taking up water and dissolving and, therefore, should be mixed with sawdust or charcoal, the same as the liquid solution of zinc chloride.

Making Cored Brass Handles

We have a number of ornamental brass handles to make that are cored out in the center and have a ball on the closed end. The core is made with a heavy print to counterpoise the ball, and two castings are made with one core by placing the patterns with the open ends in line, separated by the print. There are eight patterns on a plate and two runners and sprues. We have been casting them vertically, but the loss has been great. How should these patterns be gated so that we can make them in banded snap flasks on a machine?

The horizontal method of pouring these castings should give better results than the vertical; therefore, we suggest a change accordingly. A hollow, tubular casting with a closed end is always more difficult to make than a simple bushing because the core is only supported at one end. The hydrostatic pressure of the metal tends to float the core at the unsupported end; it tilts it in the print, and the core cuts through. In placing two castings end to end with the core print between them, the theory is that the metal entering one casting will balance the pressure produced by the metal entering the other casting; it will do this, provided the metal flows into the two castings at the same time and at the same rate. If the castings are poured vertically, it is impossible for the metal to enter both castings at the same time; it enters the bottom castings first and the core tilts in its print and cuts through in the cope in the bottom casting and in the drag in the upper casting. This will occur unless the upper core yields as the metal runs under it and is lifted from contact with the mold, in which case the upper casting might be good.

To pour them horizontally, have the molds level, place the sprues in the middle of the flask where the core prints are, and provide a heavy runner; pour the metal strong so it will enter both castings at the same time; also, use a heavy iron to hold the core.

Overcoming Porosity and Sponginess

We have experienced considerable difficulty from porous or spongy castings. We are melting in coke-fired furnaces and are using scrap metals principally. Occasionally the castings appear to be completely honeycombed.

The difficulty can be overcome by careful attention to melting details. It is essential that the brass be protected from the atmosphere while it is being melted. Charge some pieces of hard wood with the brass and let the wood burn while the brass is melting. When a little pool of brass has collected, throw in some charcoal and keep a cover at least 1 inch thick on the melting metal at all times. A little salt is also an excellent flux to use while melting. After the brass is melted and a few minutes before it is to be taken from the furnace, add ¼ pound of 15 per cent phosphor copper and thoroughly stir it into the metal. Do not allow the brass to stay in the furnace after it is melted if this can be avoided; if it is not possible to take it out when ready to pour, always have a cover of fine charcoal about one inch in thickness floating on the surface of the brass, and keep the furnace cover pushed aside a little so that the fire does not burn strongly, but keep the metal from getting chilled. Let the brass stay in the furnace a few minutes after the phosphor copper has been stirred in to enable the impurities to rise to the surface so they can be skimmed off before the brass is poured.

Casting Red-Brass Bearings

We have experienced considerable trouble in running castings in the form of half bearings, as the metal which is a red brass fails to run along the bottom edge of the sides of the bearing, which latter is 14 inches long. The misrun section resembles saw teeth, instead of being straight and smooth, and the misrun portions are black in color. We have wondered if a small addition of phosphor copper would remedy the difficulty.

The question could have been answered more intelligently if a statement had been made regarding the manner in which the bearings are molded. The question is: Are the bearings molded with the bearing in the cope, or the reverse? If the bearing is in the cope, the thin edge can be made to run fully by simply venting the edge by means of a knitting needle. This is accomplished by stitching the needle through the sand of the cope, all along the impression of the edge, making small, clean vents through which the gases can be driven by the advancing metal as the mold is poured. The fact that the misrun edges of metal show black indicates that the metal contains iron to an extent sufficient to injure its flowing qualities. It would be advisable to scrutinize the scrap sharply with a view to the removal of any iron.

If the casting is molded bearing down, and the thin edge fails to run, the drag is being rammed too hard at this point. In ramming the drag, tuck the sand well with the fingers into the bearing, and over the edges; but in butt ramming go lightly over the parts that misrun. The bearing should be well vented before rolling over the drag and the holes left by the vent wire must be filled up, to avoid a run-out. The addition of 0.25 per cent of phosphor copper will materially assist in running the castings.

Making Copper Castings of High Conductivity

We have a large number of copper castings to make which must be hard and of high conductivity. We would like to know what to alloy with the copper to attain these results. The castings will have to sustain considerable wear and must be harder than copper. We have been informed that a mixture of copper, 95 per cent; zinc, 3 per cent and tin, 2 per cent will have both wearing qualities and conductivity. Another foundryman states that an alloy of copper, 99 per cent, and iron, 1 per cent will give the desired results.

It is impossible to make hard copper of high electrical conductivity, because the hardening agent is an impurity in the copper, and impure copper has no value for electrical purposes. Of the two mixtures given, there is no choice from a conductivity point of view. The 1 per cent of iron will reduce the conductivity of the alloy to about 27 per cent of that of pure copper. The tin-zinc mixture is nothing but a red brass. The addition of 1.5 per cent tin to copper lowers its conductivity to about 40 per cent. The copper-iron alloy will be the reddest mixture and sound castings can be made from it. The iron should be added in the form of tin plate, using soda ash as a flux. Add the iron just before pulling the pot. Phosphorus also can be used to harden copper and any degree of hardness up to brittleness can be obtained. It should be added in the form of phosphor copper. When tin is present the alloy casts better; therefore, phosphor tin is often used for copper castings; about 2 per cent should be used. The castings will have about the conductivity of ordinary brass. The only way to harden copper is to make pure copper castings and harden them by forging. A Brinell number as high as 90 can be thus obtained.

Method of Mounting Patterns in a Double Match

They Are Adaptable for Either Machine Molding or for Use on the Bench When Hand Ramming is Practiced

By W H Albohn

QUANTITY production of duplicate parts owes its success in a large measure to the use of the metal matchplate. Ever since matchplates became a recognized part of foundry equipment—from the primitive followboard to the highly finished plate made of nonshrinking white metal—every change has been synonymous with ever increasing production. On the other hand, the initial cost of high grade plates is so great that a very large production is necessary to absorb it. Besides, many foundries, for one reason or another, are unable to avail themselves of the benefits of this method of mounting patterns. The plaster match of course has been in use for many years. In its general application, however, it should more properly be referred to as a followboard, for after the drag is rolled over its functions cease. It serves to support the pattern in the proper position for ramming and leaves the parting ready for the cope. But the cope was to be rammed directly on the drag and therefore half the benefit of using a match lost.

The plaster match described and illustrated herewith presents interesting features not only on account of its economy and simplicity but more particularly because it furnishes a hard firm surface on which to ram both the cope and the drag. As may be seen from the accompanying illustrations it is made in two parts, one for the cope and one for the drag. Another advantage of this arrangement lies in the fact that the cope and drag may be laid side by side on bench or machine and rammed simultaneously. Or if it is desired to work two men on the same job to save time, one man could make the drags and the other the copes without the friction usual in such cases. In the writer's judgment it will pay to use this match on orders for 50 castings or even less.

Match Taken from Frame

For its operation and use no special rigging is needed. It may be used anywhere, on the bench by hand, or on any type of squeezer or rollover machine. For this reason, if no other, it should commend itself to the owners of jobbing foundries where short orders are the rule and not the exception.

The durability of this type of match is attested by the statement that 300 or more molds have been made off some of them and that they are still in good shape. There seems no reason why they should not last indefinitely. This, however, is a feature of no particular interest for having served their purpose and there being no other order immediately in sight, it might be just as well to knock out the plaster and use the frames for another job. But if it seems expedient to save the match for future use and the frames are needed in the meantime, a few of them with a pronounced taper on the inside may be fitted up. In such cases when the order is finished it only becomes necessary to remove the bolts holding the frame to the bottom board when it can be lifted off and used for another job; the plaster form in the meantime being put away in the pattern storage.

The initial cost of these matches is slight, $4 a set being given as a fair approximation for patternmaking, molding and fitting. Larger frames of course cost more and smaller ones less. The increase in one day's output, in the writer's opinion, is usually sufficient to offset the cost of making them.

In using these matches, the molder places both the cope and drag on his bench or machine as the case may be. He rams or squeezes them and rolls them over precisely as if they were both drags. By attaching a vibrator, in shops having air pressure; or by simply rapping the drag before taking off the match, a good clean draw is

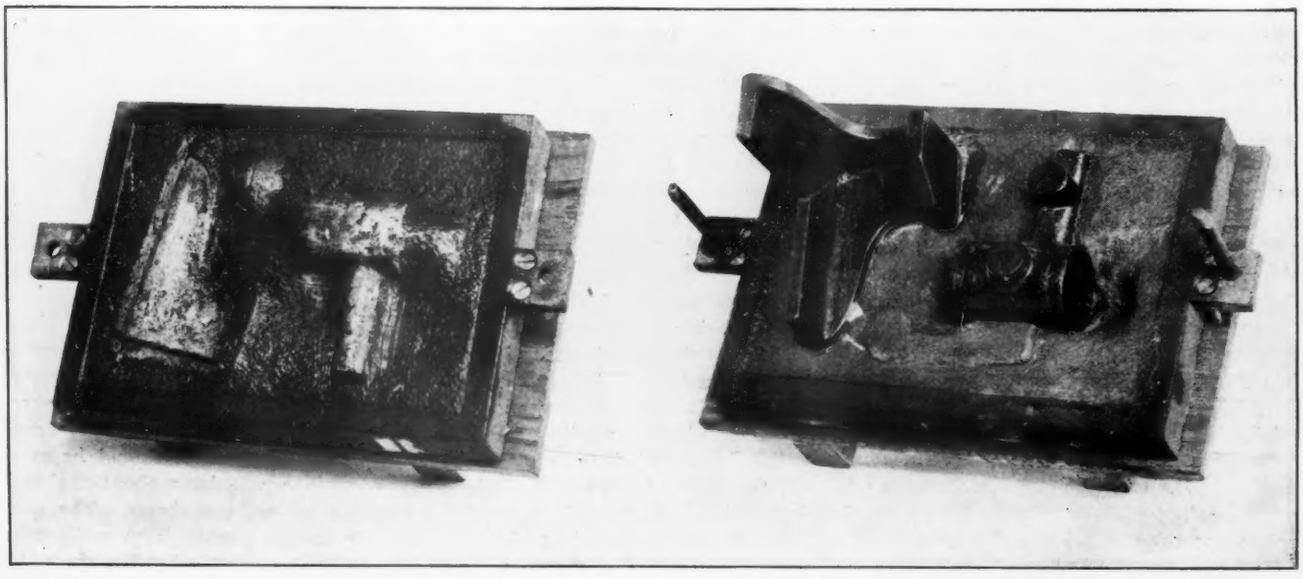


FIG. 1—MODEL OF THE COPE HALF OF THE DOUBLE MATCH SHOWING THE METHOD OF PARTING

FIG. 2—DRAG HALF OF THE DOUBLE MATCH—NOTE THE LONG GUIDE PINS TO HANDLE DEEP PATTERNS

assured. Similarly, the cope cannot fail to lift. If removing the match disturbs the face to any extent it is a simple matter to press it back into place.

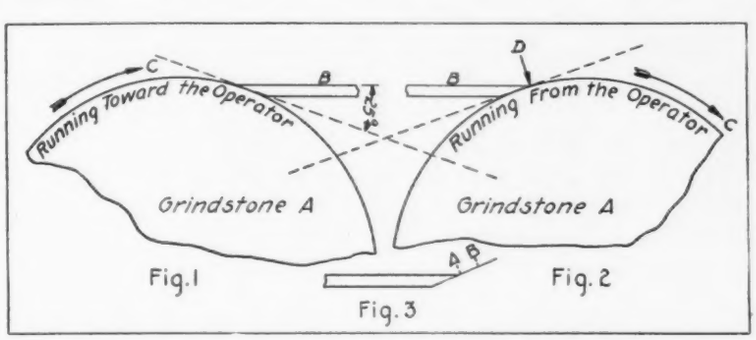
Making the matches requires no particular skill. By using all new sand better results are obtained. The patterns selected are laid on a board and a drag and cope rammed in the usual way. After lifting off and finishing the cope, the gates are cut in the drag, without, however, taking out the patterns. In order to anchor the patterns and prevent warping, wood screws can be driven in a few turns at convenient points. Brads may be used with very thin patterns, or battens may be laid across before pouring in the plaster and after the latter sets the pattern can be screwed down firmly. In the case of iron patterns two or three holes are drilled and tapped beforehand and short machine bolts inserted before pouring in the plaster.

In preparing the plaster, the best results are obtained by mixing it by hand in a pail until it just begins to set. Place the frames in their places, one on the cope and the other on the drag. Spray oil all over the joint and pattern, then pour in the plaster; if it is sluggish spread it along by hand. The less water used the better; it will dry more quickly and will not shrink or crack. After the frames are full they may be scraped off flush and when the plaster is set boards are placed at the back and held there by bolts depending from the same lugs that hold the pins. In case of extra large frames, the plaster may be stiffened by running rods or heavy wires from side to side. The guide pins should be sufficiently long to insure a straight draw on the deepest pattern which is apt to be received.

Methods for Grinding Patternmaker's Tools

By M E Duggan

AS a patternmaking apprentice, I was instructed to grind my tools with the stone running toward me. There must be a reason for this. If I attempted to grind my plane iron or any one of my edge tools with the stone running from me, I was corrected or told that I did not know how to hold a tool on a grindstone. Now, if a workman tells me that I am doing a job in a wrong way, it is quite natural that I expect that this man be able to show me the right way and also to explain why it is the right way. I am old at the patternmaking game and have ground a great many edge tools on grindstones revolving from me; perhaps this was contrary to good practice, but I always managed to have sharp tools.



PROPER AND IMPROPER METHOD OF GRINDING EDGE TOOLS

"Why is grinding an edge tool on a stone revolving toward you considered to be good practice and the correct way?" This question is frequently asked by woodworkers in general. Intelligent answers to this question are mighty few.

Let us consider the grinding of a jack plane. The jack plane is employed for roughing-off the surface timber; the stock is made of beechwood and the blade of steel. The blade acts most effectively when it is well ground away from the corners. The bevel face should be at an angle of 50 degrees to the flat face.

In Fig. 1, *A* represents the grindstone, *B* the plane blade, and *C* the direction in which the grindstone is supposed to revolve. The grindstone should be kept true and liberally supplied with water. The straight face of the blade should not be ground away, nor touched upon the stone. The pressure with which the blade is held against the stone should be slight at the finishing part of the grinding process, to prevent leaving a long, ragged burr on the end of the blade, which will be the case if much pressure is applied, and it will occur to a slight extent even with the greatest of care.

The blade should not be held still upon the grindstone, no matter how true, flat or smooth the latter may be, but it should be moved back and forth across the width of the stone, which not only will grind the blade bevel, even and level, but will tend also to keep the grindstone in good order.

If a grindstone is in good condition, that is, true, flat and level, or slightly rounding, as it should be, it tempts the workman to grind the plane blade with the stone running toward him, as shown in Fig. 1. He does this for the following reasons:

If the stone, *A*, travels in the direction of the arrow, *C*, the plane blade, *B*, will relieve the abrasion of the stone at the cutting edge first, thus leaving it clean and with no tendency to leave a long, ragged edge; but if the blade is held on the other side of the stone, that is, with the stone running from the operator, as shown in Fig. 2, the result will be a long, ragged edge on the plane blade, especially if much pressure is placed on the blade. In Fig. 2 the grindstone is revolving in the direction of the arrow, *C*, in which case it becomes evident that the plane blade will receive some pressure on its edge in the direction of the arrow, *D*, and the metal at the cutting edge of the blade, being very thin, yields to this pressure and bends back instead of abrading off, leaving a long, feather edge, as shown in Fig. 3, from *A* to *B*. In many cases this edge breaks off further back than it should and inevitably breaks off when the blade is applied to the oilstone, leaving upon the face of the oilstone particles of the steel which must be removed before a good edge can be secured. As a rule, however, this feather edge is broken off by tapping the blade on the palm of the hand, or it may be removed by passing the edge lengthwise on a piece of wood.

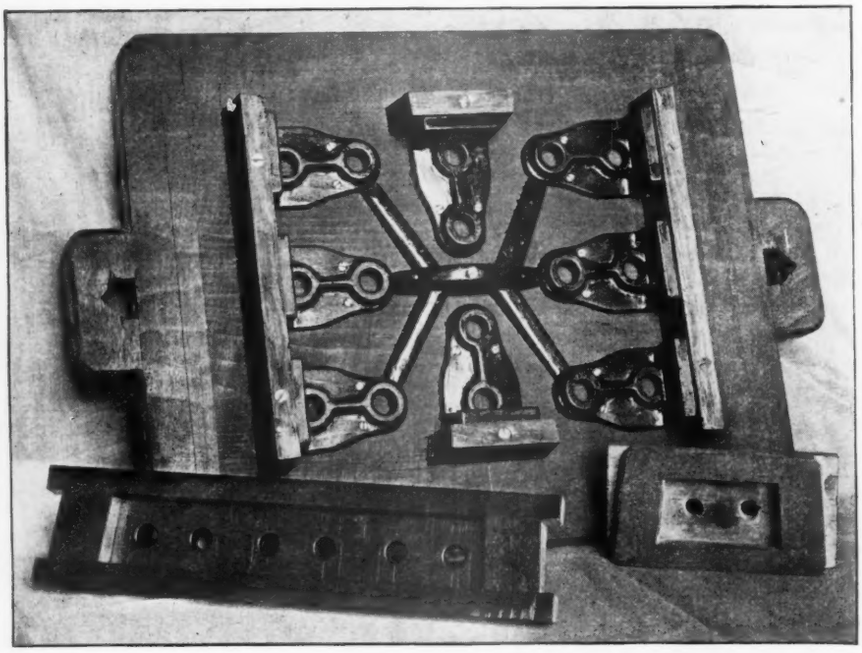
However, it is considered to be the better way, to hold the blade as shown in Fig. 1, but there are other considerations which sometimes render this impracticable. For instance, if the stone is out of true, the high spots in the stone will strike against the cutting edge and render it impossible to hold the blade steadily, and hence it is impossible to grind it true. If the stone has soft spots in it, as most stones have, the blade will dig into

these soft spots and also will be thrown off the stone when encountering an unusually hard spot. If, in consequence of digging-in a soft spot, the blade catches, the cutting edge will be ground off completely. It is only under exceptional and unusual circumstances that the blade can be ground in the position shown in Fig. 1. Therefore, it is advisable to grind it in the position shown in Fig. 2, which is safer and surer.

What has been said about grindstones being out of true, high spots and soft spots, can be applied to the oilstone. Not one oilstone in 10 is in good cutting condition. Most of them have concave and uneven surface that makes it almost impossible to put a knife in good cutting condition without altering the shape of the cutting edge.

In oilstoning a plane blade, the straight face should be kept level with the face of the oilstone, so that the cutting edge may not be beveled off. Not much application to the oilstone is necessary to the straight face, because that face is not ground upon the grindstone, and it only has to have the wire edge or burr removed, leaving an oilstone polish all along the cutting edge. The oilstoning should be performed alternately on the flat and bevel faces, the blade being pressed lightly on the oilstone toward the last part of the operation, to leave as fine a wire edge as possible. The wire is the edge or burr which bends or turns over at the extreme edge of the tool. This wire edge is reduced to a minimum by the oilstone and is then so fine that it is of little account. However, it is advisable to remove the wire edge after oilstoning; this can be done by passing the edge over a leather strop or by buffing backwards and forwards on the palm of the hand.

It is a mistake to have only one grindstone for the general uses of the patternmakers and the carpenters; a grindstone that is used by the carpenters, in nine cases out of 10, is the stone that is used by the laborers for grinding picks, shovels, etc. In a shop where these conditions prevail, it is almost impossible for the patternmakers to keep their tools in good cutting condition for the heavier tools of the carpenters will put the grindstone in bad condition, making the surface rough.



ARRANGEMENT OF PATTERNS ON A MATCHPLATE SECURES ADDITIONAL STRENGTH IN THE COMPLETED MOLD

Grouping Patterns for Molding

By J. L. Gard

The accompanying illustrations show eight small bracket patterns assembled on a matchplate for molding. The reason for the method of grouping these patterns may not be apparent from observation, but in this grouping a real economy was effected. Holes are cored through the base of each of these brackets. The patterns might have been arranged in any number of different ways, in accordance only with the system of gateing employed. The use of the cores for the base holes, however, suggested the value of the core print in reinforcing the mold as a unit. Accordingly, the brackets are arranged with the bases around the outside of the mold. In this way the core prints form a wall about the outer edge of the flask, dispensing with the need for jackets around the outside of the snap flask mold. This arrangement has effectively prevented run-outs. It will be noted that the patterns are screwed to the board as nails would not hold.

How to Learn Pattern Making

By John Parker

In a last year's issue of THE FOUNDRY, I noted a brief article by M. E. Duggan captioned "The Best Way to Learn Pattern Making" in which he speaks of two kinds of patternmakers, the theoretical and the practical. He claims to be a theoretical patternmaker and that from experience he finds that the pattern shop is not where one should start to learn the trade. He recommends the initial apprenticeship in the foundry where a few months should be served so that the embryo patternmaker will learn something about molding and get an idea of how patterns are actually used in the foundry.

This contention that the apprentice should have this knowledge before going into the pattern shop is all right in a sense, and is a valuable asset to him as a patternmaker, but I think the system he advocates should be somewhat inverted.

In my opinion, backed by 10 years' experience in the training of patternmaker apprentices, I would follow the method pursued by one large concern and which has proven highly successful; this consists of placing the apprentice in the pattern shop first; give him a year there and by that time the instructor can form a definite idea as to whether he is adapted to the business of patternmaking. Then, if the apprentice has shown any marked ability in that line, he will in all probability begin to investigate and ask questions as to why this is done in one way and why something else is done another way.

If he has not shown any marked ability for patternmaking at the end of a year, he should be transferred to another department. On the other hand, if he has shown the interest and ability, he should be sent to serve under a good molder in the foundry for six months; in that time he will have learned why he makes patterns and core boxes in the way he has been taught in the pattern shop.

After having been in the foundry I find that the apprentices have an added interest in their work and generally make good mechanics. The course of instruction should consist of pattern shop practice for one year and then foundry work for six or more months; one hour every day in school to learn drawing, geometry and trigonometry and the balance of

FORMULAS FOR THE BRASS FOUNDRYMAN

Pickling Solutions For Iron

When cast or malleable iron has been cleaned preliminary to galvanizing operations, or for any other purpose, and it becomes necessary to use a pickling solution, the first consideration is to remove oil and grease. To accomplish this the castings are thoroughly washed in the following solution:

Ordinary soda lye	38 pounds
Hot water	100 gallons

Any proportion of the above may be used. The castings are immersed from 5 to 10 minutes, or longer if the grease is caked on, after which they are removed and washed in hot water. The precautions to be observed are to keep the lye solution clear of floating oil or fat by skimming frequently; and to renew the solution whenever it becomes greasy or brownish in color. After being cleaned of grease and washed in hot water, the castings are immersed in the following pickle:

Water	76½ gallons
30 per cent hydrofluoric acid	15 gallons

The commercial hydrofluoric acid is used, and the strength of the pickling solution should be about 1.026 at 80 degrees Cent. If the density should be less than this, add acid to bring up the strength. When the solution gets brownish and deposits form upon the castings, it must be renewed. The acid bath is worked at the same temperature as the alkaline bath, which ranges from 60 to 80 degrees Cent. During immersion in the acid the castings should be well shaken and dipped several times to bring the solution into contact with every part.

The castings are removed from the acid solution after they are clean and are rinsed well in hot water. The temperature of the water should be around 80 degrees Cent. After thorough washing the castings are immersed in the following solution to neutralize any acid:

Lime, either quick or air slacked	20 pounds
Water	100 gallons

When the solution changes from a milky to a brownish color it must be renewed. Litmus tests will show the condition of the solution and when it loses alkalinity it must be run off, the tank thoroughly washed out and new solution prepared. From the neutralizing tank the castings are placed on an inclined screen and allowed to dry.

FORMULAS FOR THE BRASS FOUNDRYMAN

Pickling Solutions For Brass

Roseleur's Dip

For removing sand from brass and bronze castings the following dip, known as Roseleur's dip, is much used:

	Gallons
Muriatic acid	6
Old aqua fortis (nitric acid)	1
Water	2

Submerge the castings and leave in the acid for a half hour, or more if required to loosen the sand. Then remove and rinse and submerge in the following bright dip:

Yellow aqua fortis, 36 degrees	1 gallon
Sulphuric acid, 66 degrees	1 gallon
Common salt	1 ounce

Mix this solution a day or two before using to allow it to cool. Add the sulphuric acid to the nitric acid, and lastly the salt. If the action is too rapid, add more sulphuric acid. The aqua fortis or nitric acid should be yellow in color, and the dip is spent when it works slow, or when the castings have a bluish white film.

Fumeless Bright Dip

In place of the above bright dip, the following dip known as the *fumeless* bright dip may be used:

	Pounds
Sulphuric acid	10
Saltpeter	2
Water	5

Dissolve the saltpeter in the water, and add the sulphuric acid gradually, in a thin stream, stirring continually with a glass rod. The water will get very hot, and time may be allowed for it to cool before all the acid is added. Do not use the dip until it has become almost cold.

After the castings are dipped they should be rinsed in cold water, then in hot water containing some whale oil or fig soap in the proportions of one ounce of soap to one gallon of water. The castings are then allowed to dry off naturally as a thin film of soap dries on and protects them against oxidation.

THE FOUNDRY DATA SHEET, JUNE 15, 1919
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may cut into

the time in the pattern shop, if the apprentice has any adaptability and brains he ought to develop into a first class patternmaker.

Calculation of Storage-Bin Space

By H. E. Diller

Question:—Please tell us the amount of space which will be occupied by one ton of pig iron, coke and sand. We wish to use this information in designing storage-bins.

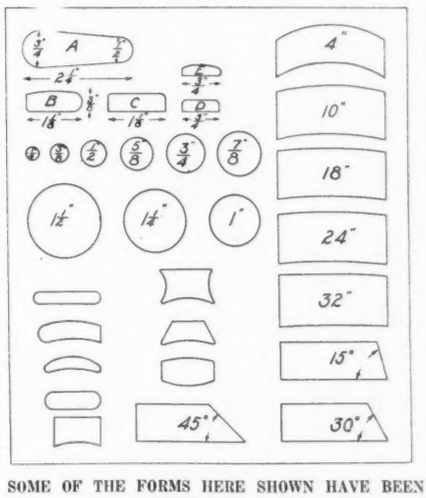
Answer:—The space occupied by these materials will vary considerably according to different factors. Pig iron piled by hand will take up less space than if it is dropped in a heap with a crane. Sand will vary according to the kind it is, some sands being 20 per cent heavier than others. Moisture in sand may also increase its weight by as much as 30 per cent. There is also a big variation in the weight of coke which will range from 33 to 50 pounds to the bushel. The following are the averages upon which we would recommen basing storage-bin calculations:

Pig iron..... 7.5 cubic feet per ton
Sand .....22.0 cubic feet per ton
Coke .....80.0 cubic feet per ton

Special Shapes for Sandpaper Blocks

By J. L. Gard

A feature usually lacking in pattern shops is an adequate means for sandpapering the many irregular surfaces found on patterns. The hand or fingers are used in many places where they do



SOME OF THE FORMS HERE SHOWN HAVE BEEN FOUND SERVICEABLE IN REACHING RECESSES

not fit and cannot do satisfactory work in a reasonable time.

To overcome this condition a system of blocks as illustrated has been evolved. They are considered worth the cost not only for the time and labor saved, but for the more satisfactory results attained. These blocks are designed to use sandpaper sheets cut first into three parts and then into two and into four parts.

Blocks *A* and *B* are 9 inches long, and *C*, *D* and *E* are 4½ inches long. These five blocks are kept on the bench and are suitable for general use, as with these all the more common shapes can be reached.

For circular forms we have round blocks from ¼ to 4 inches in diameter, varying by 32nds from ¼ to 1 inch, by 16ths from 1 to 2 inches, by 8ths from 2 to 3 inches, by 4ths from 3 to 4 inches and from 4 inches up to a 32-inch circle by curved blocks as shown, the circles which they will fit being 4, 4½, 5, 5½, 6, 7, 8, 10, 12, 14, 16, 18, 21, 24, 28 and 32 inches respectively. The convex and concave side are the same radius on each block. These blocks are 2¼ x 9 inches. Then we have blocks with angle edges as shown and other useful shapes are shown in group *G*. All these blocks are marked plainly to identify them.

Standardizing Flask Pins, Pin Centers, Etc.

By L. T. L.

For the purpose of facilitating foundry operations it would be advisable for foundry men to discuss the desirability of adopting standard size pins for iron flasks and the establishment of standard distances between pin centers on given sizes of flasks. It also would be advisable to so construct matchplates, matchboards, vibrator frames, etc., so that they could be adapted readily to any style of snap flasks without being compelled to change the size or style of the pins on these flasks. The purpose of these suggestions is to make it easier for the casting buyer to furnish patterns at his expense ready for mounting on molding machines. I have made a study of this problem and I am convinced that if these recommendations are carried out, the foundryman's work will be greatly simplified.

Choosing Shrinkage Rules

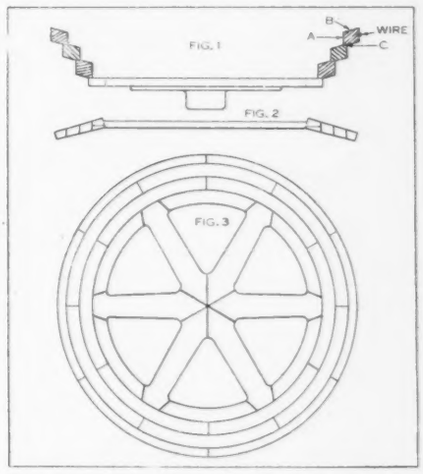
By M. E. Duggan

When I first started in the patternmaker's trade I purchased four shrink rules. These were scaled for ⅛, $\frac{3}{16}$, ¼ and $\frac{5}{16}$-inch shrinkage per foot. Each rule was graduated in eighths, tenths, twelfths and sixteenths. I have never used the eighths or tenths graduations and am constantly annoyed by the need to guard against using the wrong graduation. I could have saved myself this annoyance had I purchased a rule with ⅛ and $\frac{5}{16}$ only marked on it. Never purchase one rule with all four divisions marked on it as every line or figure that is unnecessary on a rule is an invitation to error. A single line of figures marked in the center is much better than a double row of figures at the edges of a rule. The latter can be read in either the right or the left graduations as the workman wishes.

Making the Joints for a Bevel-Gear Pattern

By J. L. Gard

For a standard pattern of the kind shown in Fig. 1 it is essential that the



EACH RING IS TURNED SEPARATELY THEN CUT OFF AND LATER ALL THE RINGS ARE FITTED TOGETHER

rim be built to prevent warping from the original turned shape. A gear casting from a warped pattern will never run properly, and will be noisy, for the reason that the pinion teeth will mesh deeper at some parts of the revolution than at others.

Fig. 1 shows how a wheel of this type was made by glueing the segments composing the rim one above another, using the arms as a face plate. After all these were in place a groove was turned on the outside of the largest diameter and a piece of baling wire twisted around it to hold this course together after it was cut off. Next, the face *B* was trued to the proper angle and the inside *A* turned, it was then cut off at the joint *C*. The outside of the next smaller course of segments was then turned to the same diameter as the inside diameter *A*, a slight taper being allowed on each for ease in fitting, the face of the second segment being trued to the proper angle. The larger ring then was glued around the next smaller one. This operation was repeated for the next two circular joints.

Fig. 2 shows the rim and arms after joints were made and the rim turned. Fig. 3 shows how the joints were lapped one over another. This method of building a rim is not new. The feature, however, consists in turning the circular joints instead of starting from the inside and building out by fitting each segment separately from a sawed joint.

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From The International Viewpoint

AS a result of the unusually warm reception given the president of the American Foundrymen's association on his recent trip to Great Britain and France, new opportunities for co-operation between American, British and European foundrymen have been created. British producers of castings are particularly anxious to establish close and cordial relations with their American confreres and the French are equally so. As pointed out on another page in this issue, in the report of the reception tendered the president of the American Foundrymen's association in Sheffield, Birmingham, Coventry and elsewhere in England, producers of castings on both sides of the Atlantic have a great deal to gain by establishing closer relations with one another. It is now generally conceded that the tremendous forward strides made by the American foundry industry during the past decade is in no small measure due to the free interchange of ideas which has been fostered during that period by the technical press and the leading foundry associations. Such being the case, how much more progress might be made if the same free interchange of ideas and information should become international? Important forces are now at work toward the internationalization of the castings industry. As has been pointed out frequently by various prominent speakers, the league of nations will be a failure and the peace treaty will become a scrap of paper unless practical co-operation can be secured between the industries of the allied nations. The problem of internationalizing the foundry industry therefore stands forth as more than merely a business proposition—in fact it reaches straight down into the roots of the question of the world's future political stability. But viewed even from a more narrow standpoint, much good can be accomplished. There is a great deal we can learn from British foundrymen, and vice versa. For instance, we in this country have emphasized the practical side of things with the result that our labor output is superior to any in the world and our shops more thoroughly equipped with up-to-date machinery and appliances for speeding up production than the average British or European foundry. On the other hand, even the most superficial survey of British foundry conditions demonstrates the fact that more attention is paid to the scientific fundamentals of the business in the United Kingdom. The aggressiveness of British foundrymen along scientific lines is further illustrated by the flourishing condition of the British Foundrymen's association with its 1600 members. Although there are less than half as many shops in Great Britain as in the United States, this organization has an appreciably larger membership than the American Foundrymen's association. The result of all of this stress on science is quality. And the war has taught us, in this country, that quality must go hand in hand with quantity. The day is rapidly passing when foundrymen can longer consider it a point of honor to have no acquaintance with the iron-carbon equilibrium diagram, for it is along just these lines that progress now points its steady finger. Science after all is simply organized knowledge, which is the only kind that can be depended upon to produce satisfactory results in the shop day-in and day-out.

Trade Outlook in the Foundry Industry

TWO distinct factors point to continued optimism in the foundry industry. Pig iron buying by foundries has been heavier during the past two weeks than at any previous time since the armistice. Further, almost without exception the manufacturers of foundry supplies and equipment report not only an active interest, but a steady increase in orders for the machinery and materials needed for expanding foundry facilities. It is generally accepted that pig iron prices will not undergo a radical reduction prior to the first of the year and foundries which have not covered are buying freely. The most notable feature of pig iron prices is the tendency to reduce southern grades by disregarding differentials and in some cases by absorbing the freight in order to enter the northern and eastern markets. In the Chicago district southern producers are delivering high silicon iron, preferably 2.75 to 3.25 per cent and nothing under 2.25 per cent, at $30.25 which is the price which would be asked by local producers were they to make these grades. Malleable foundries are buying steadily, although it is stated that this movement is actuated rather by depleted stocks than any prevailing or anticipated prices. Some foundrymen hold that the castings buyer is under a mistaken impression that pig iron prices are on the descent, and that the price of finished castings will also drop. They fail to note that the greater part of the cost of the manufactured article depends on other factors. The prices of labor, sand, lumber, core-compounds and the numberless items which enter into the cost of the finished castings are showing no signs of decreasing. In fact, one company which operates three foundries states that the overhead as represented by labor alone has advanced 15 per cent in the past two months. The cautious attitude on the part of the user of castings is often carried to the point which marks the extreme limit of hand-to-mouth ordering. One manufacturer of sewing machines who ordinarily carries a reserve stock of from 400 to 500 tons of castings, during the past few months has been buying only as the castings were urgently needed. Recently this manufacturer was obliged to secure about 10 tons of castings by express to meet his needs. This tendency no doubt is holding back a good volume of business in all lines. Returning confidence is becoming evident.

Prices of Raw Materials for Foundry Use

CORRECTED TO JUNE 7

Iron		Scrap	
No. 2 Foundry, Valley	$25.50 to 26.50	Heavy melting steel, Valley	$16.00 to 16.50
No. 2 Southern, Birmingham	24.75	Heavy melting steel, Pittsburgh	16.00 to 16.50
No. 2 Foundry, Chicago	26.75	Heavy melting steel, Chicago	16.00 to 16.50
No. 2 Foundry, Philadelphia	28.35 to 29.85	Stove plate, Chicago	17.50 to 18.00
Basic, Valley	25.75	No. 1 cast, Chicago	22.00 to 22.50
Malleable, Chicago	27.25	No. 1 cast, Philadelphia	21.00 to 22.00
Malleable, Buffalo	27.25	No. 1 cast, Birmingham	20.00 to 22.00
		Car wheels, iron, Pittsburgh	21.00 to 22.00
Coke		Car wheels, iron, Chicago	21.00 to 21.50
Connellsville foundry coke	4.50 to 5.25	Railroad malleable, Chicago	17.50 to 18.00
Wise county foundry coke	6.00 to 6.50	Agricultural malleable, Chicago	17.00 to 17.50

Malleable Unchanging

Little change is noted in malleable operations which continue in the neighborhood of 70 per cent. Those shops serving the automobile industry have continued practically in the same volume, although labor difficulties and temporary suspensions for changes in design have brought a slackening influence in some malleable shops. It is thought that implement demands are showing betterment, even though a seasonal reaction is to be expected. Prospects for railroad buying depend entirely upon misty futurities. It is thought in Washington that with the prospect of the resumption of private control imminent, the railroads may be permitted to buy individually to fill their immediate needs. The rail administration's order for 200,000 tons of open-hearth rails for immediate and urgent needs to be followed by 300,000 tons in the near future may not be accepted as an indication of the policy to govern the purchase of rolling stock and equipment into which malleable castings enter to such a large degree.

Gray Iron is Better

Practically all gray iron shops show an improvement in operations. The jobbing shops report a diffidence in placing advance orders, as buyers place undue weight upon slight price changes in pig iron alone. However, the volume of immediate orders is growing steadily. Automobile shops still are very busy, while the tractor plants are contributing a large share to the aggregate tonnages ordered. Swinging into line on a definite monthly schedule of production, together with the intensive effort to spread the buying of passenger automobiles and tractors over the entire year is expected to stabilize the operations of shops which specialize on this class of castings. The heavy gray iron shops have not yet experienced a full revival of demand, but the installation of new equipment in these foundries and the advance buying of iron indicate an optimism based upon the certainty of early orders. Cast iron pipe buying shows improvement and carries with it increased activity in pipe foundries, while the oil well supply manufacturers, stove and furnace shops are engaged nearly to capacity.

Nonferrous Expectant

A rising market in copper is attributed in some degree to anticipated foreign demand, but the main influence is said to be anticipated expansion in demand for manufactured brass products in the next quarter. Aluminum foundries report better business, though automobile manufacturers who furnish the greater portion of the demand for cast aluminum products are not yet buying as far in advance as was customary previous to the war. Casting copper is quoted at 16.50c, New York. Prices on other brass foundry materials based on New York quotations are: Lead, 5.25c; tin, 72.50c; antimony, 8.37½c to 8.50c; aluminum, No. 12 alloy, producers' price, 31.50c, and open market, 26c. Spelter is quoted at 6.15c, St. Louis. The comparison of the average prices on nonferrous metals for April and May is as follows:

	Copper	Lead	Spelter	Antimony	Aluminum
April average	15.39	3.07	6.18	6.70	25.33
May average	15.68	5.11	6.11	7.46	26.00

COMINGS AND GOINGS OF FOUNDRYMEN

STEPHEN C. MASON, recently re-elected president of the National Association of Manufacturers, has been identified with the iron and steel industry for the past 23 years, the period of his association with the McConway & Torley Co., Pittsburgh, manufacturer of malleable and steel castings, forging ingots and car couplers. Mr. Mason was born at Fairlee, Vt., Feb. 1, 1861. He was educated in the common schools of

STEPHEN C. MASON

that town, at Orford academy, Orford, N. H., the Bradford academy, Bradford, Vt., and the Newbury seminary, Newbury, Vt. In 1880, at the completion of his schooling, he accepted a position in the general offices of the Connecticut & Passumpsic River railroad at Lyndonville, Vt. He remained with this railroad serving in various capacities until March, 1888, when he accepted a position with the Interstate Commerce Commission in Washington. When a division for the compilation of railroad statistics was created in that body, Mr. Mason was appointed chief clerk and later was promoted to assistant statistician of the division. He resigned that position Jan. 15, 1896, to become identified with the McConway & Torley Co. and after serving in various capacities, was elected secretary of the company in January, 1900. He was elected a director of the company in August, 1905, and still holds both of these positions. Mr. Mason for sever years past has been vice president of the Steel Founders' Society of America and before his election as president of the National Association of Manufacturers about a year ago, served as a director and vice president from Pennsylvania in that organization.

C. A. Truesdale has been elected president of the Hill & Griffith Co., Cincinnati, succeeding David T. Richards, who died recently. Mr. Truesdale is succeeded as secretary by E. M. Lewis who was formerly sales manager.

W. M. Carty, formerly assistant superintendent of the American Brake Shoe & Foundry Co., Chicago plant, has been made superintendent at the Pine Bluff, Ark., plant of the Standard Brake Shoe & Foundry Co. The latter company recently purchased equipment to increase its capacity from 350 to 800 tons per month.

George A. Fuller has been placed in charge of the newly established office of the Federal Foundry Supply Co., Cleveland, which is located at 760 Book building, Detroit.

H. A. DeFries, chief engineer of Hamilton & Hansel, Inc., New York City, addressed the Philadelphia Foundrymen's association at a meeting held June 4 on the subject "The Rennerfelt Electric Arc Furnace for Melting Steel and Nonferrous Metals." This was the last meeting of the association to be held until early in September.

J. P. Brennen, after more than 40 years' activity in the Connellsville coke regions has retired from active control of the Thompson Connellsville Coke Co., which was assumed recently by the Hillman interests. Mr. Brennen still is a heavy stockholder in the company and continues as president of the Producers' Coke Co., an agency, and as vice president of the Connellsville Central Coke Co. Mr. Brennen continues on the board of directors of all three companies named.

J. F. Geary, recently discharged from the army after 21 months' service in France has resumed his duties as foundry superintendent for the Thatcher Furnace Co., Garwood, N. J.

J. L. Lonergan has been elected secretary of the newly organized Syracuse Foundrymen's association, Syracuse, N. Y. Mr. Lonergan is connected with the Morris Machine Works, Baldwinsville, N. Y.

George N. Jeppson, works manager of the Norton Co.; Harry W. Goddard, president and treasurer of the Spencer Wire Co., and Frank H. Willard, assistant general manager of the Graton & Knight Mfg. Co., all of Worcester, Mass., have been made members of a committee of five to organize the Worcester Housing Corp. to increase the housing facilities of that city.

F. M. Russell, formerly treasurer of the Union Steel Castings Co.,

DAVID THOMAS RICHARDS

Boston, has resigned to become New England representative for the Bayonne Steel Castings Co., Bayonne, N. J.

Raymond A. Cole has become connected with the engineering department of the Norton Co., Worcester, Mass. Mr. Cole formerly was engineer in the machine gun department of the Colt's Patent Fire Arms Co., Hartford, Conn.

David Thomas Richards

David Thomas Richards, who was widely known in the foundry industry, died recently at a hospital in New York where he was undergoing treatment for appendicitis. Mr. Richards was born in Youngstown in 1870. His early education was directed toward mastering telegraphy, but realizing the limitations of this vocation he took a short business-college course and obtained a bookkeeping position in

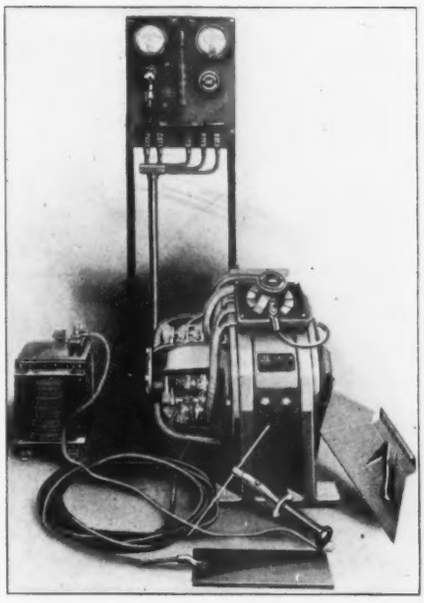
Chattanooga, Tenn. This step led him into the foundry industry when a few years later he became bookkeeper for the Chattanooga Pipe & Foundry Co. In 1899 he accepted a position with the Chattanooga Implement & Mfg. Co., and was elected secretary and treasurer. Eighteen years ago he was made treasurer of the Hill & Griffith Co., Cincinnati, manufacturer of foundry equipment and supplies. By close application and hard work he demonstrated his business ability and in 1913 he was elected president of the company, a position which he held until his death. Mr. Richards enjoyed an extensive acquaintance in the foundry and allied industries, and his sense of fairness, kindliness and consideration secured to him a great number of friends. He is survived by his widow, a son and one daughter.

Death of Joseph L. Gard

Joseph L. Gard, prominent in the foundry industry of the west and a contributor to THE FOUNDRY for a number of years died recently at his home in Denver. Mr. Gard, who was 54 years of age, moved to Colorado in 1887. Two years later he established a pattern shop in Denver and continued to be actively engaged in an executive capacity until the time of his death. He is survived by his widow and two daughters.

Two Compact Types of Electric Welders are Developed

The United States Light & Heat Corp., Niagara Falls, N. Y., recently developed two types of electric welding equipment. The first of these is supplied with a motor-generator set consisting of a 7½-horsepower direct



NEW ELECTRIC WELDING EQUIPMENT

or alternating current motor on the same shaft with a 4-kilowatt special type generator. The generator is inherently regulated, compound wound and self excited, with a drooping voltage characteristic, said to be peculiarly suited to arc welding practice. This unit is designed to handle work which may be transferred readily and brought to a fixed location for welding.

The second type of welder, which is shown in the accompanying illustration, employs a converter for use on 100 to 125-volt circuits. This outfit is provided with a portable truck equipped with a control panel, reactor, cover and cable reel. The entire installation may be mounted on a truck 28 x 54 inches and 55 inches high and weighs 1500 pounds complete. It is stated that the converter delivers current at the arc through an arc stabilizing reactor with an efficiency of from 65 to 70 per cent.

New Foundry Plate Specifications

In order to facilitate the ordering of steel foundry plates, the Moltrup Steel Products Co., Beaver Falls, Pa., has issued a specification sheet covering nine different types of plates. The sizes of standard parts of the plates, such as extensions for flask guides, are shown in the drawings, but the purchaser is asked to specify the spacing of holes for side and end guide pins and to indicate the overall dimensions of the plate desired. Supplementary drawings on the specification sheet show the actual size of holes for standard flask pin guides. In an explanatory paragraph the need of giving the outside dimensions of the flask when ordering plates is emphasized. It also is suggested that the manufacturer be allowed to cut the plates to exact form and to punch the flask pin holes. If this work is done before the final straightening of the plates, they will be straight whereas if the purchaser attempts to punch the holes without proper equipment the plates may be distorted.

The Iowa Radiator Co., Cedar Rapids, Iowa, recently changed its name to the Chandler Heater Co. and increased its capitalization to $150,000 to care for plant extensions. No change was made in the personnel of the organization.

The Chicago Electric Steel Co., Chicago, plans to install an additional 10-ton electric furnace. C. W. Lyon is general manager of the company and C. S. Daniels is purchasing agent.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

An addition, 80 x 100 feet, will be erected by the Springfield Foundry Co., Indian Orchard, Mass.

Erection of a foundry, 30 x 180 feet, is said to be planned by the Pan Motor Co., St. Cloud, Minn.

A foundry, 48 x 151 feet, is being erected by Franklin Williams, Inc., Newark, N. J.

Phillip H. Mallory and associates recently acquired the Abendroth Foundry, Greenwich, Conn.

A plant, 60 x 160 feet, will be erected by the Malleable Iron Co., Guelph, Ont.

A recent increase in capital was made by the Conservation Stove Co., Little Rock, Ark., and the company is reported planning to enlarge its plant.

The Charles Bohn Foundry Co., Detroit, is reported seeking a site outside Detroit on which to erect a branch plant.

Leistner & Sons, St. Charles, Mo., are reported planning the erection of a machine shop, 48 x 60 feet and a foundry, 15 x 30 feet.

The Damascus Bronze Co., 928 South street, Pittsburgh, plans the erection of a building, 80 x 80 feet, at Leedsdale and Sturges street.

Contracts for the erection of a foundry, 100 x 200 feet, have been let by the Davis Foundry Co., Lawrence, Mass.

The Steel Casting Corp., Altavista, Va., recently increased its capital stock from $50,000 to $75,000. J. E. Prochu is president of the company.

Erection of a foundry at Hatboro, Pa., 90 x 120 feet and 40 x 142 feet, is being planned by the Roberts & Mander Stove Co., Philadelphia.

A foundry and machine shop on Railroad avenue, Pittsburgh, has been leased by the Best Engineering & Mfg. Co.

A foundry and office building, 25 x 50 feet, will be erected by the Flockhardt Foundry Co., Newark, New Jersey.

The Lycoming Foundry & Machine Co., Williamsport, Pa., has increased its capital from $150,000 to $1,000,000, preparatory to enlarging the facilities

of its plant for the manufacture of automobile motors.

S. B. Stein, Inc., Osceola, Pa., is having plans prepared for the erection of a machine shop and steel foundry. Details are not available at present.

The Novelty Mfg. Co., Sterling, Ill., has let a contract to John M. Powers, for the construction of an addition to its foundry, to be 40 x 120 feet.

Capitalized at $25,000 the Interstate Foundry Co., Waterloo, Iowa, recently was incorporated by G. E. Metcalf and E. A. Lamb.

Work is expected to be started soon on the erection of a plant for the Iowa Malleable Iron Co., Fairfield, Iowa.

Authority to change its name to the Perkins Machine & Foundry Co. recently was granted the Perkins Foundry Co., Amsterdam, N. Y.

It is expected the gray iron foundry being erected for the United Brass & Aluminum Co., Port Huron, Mich., will be ready for occupation about July 1.

The Frazer & Jones Co., Syracuse, N. Y., manufacturer of castings, is expected to start work soon on the erection of a plant addition.

John H. Witting is manager of the Bronz-Alumina Corp., Buffalo, which plans to erect a foundry, 37 x 102 feet.

Fire which broke out in the plant of the Union Malleable Iron Co., East Moline, Ill., was extinguished before any serious damage was done.

The American Steam Gauge & Valve Co., Boston, has taken over the property and business of the R. B. Phillips Mfg. Co., Worcester, Mass.

A recent increase in capital from $50,000 to $125,000 was made by the Homestead Valve Mfg. Co., Homestead, Pa.

A permit has been taken out by the Estate Stove Co., Hamilton, O., for the erection of a plant addition on Edison avenue.

Work on the new buildings at the plant of the Dayton Malleable Iron Co., Ironton, O., is well under way. The buildings are expected to be ready for occupancy shortly.

Incorporation papers recently were issued to the Six Stove Men Co., Dayton, O. The company, which is capitalized at $25,000, is headed by Milton M. Tuteur.

The plant of the Minerva Motor Car Co., Minerva, O., has been acquired by the Minerva Foundry & Machine Co., which was recently incorporated with $20,000 capital.

Control of the Carroll Foundry & Machine Co., Bucyrus, O., recently was transferred from T. E. Menks, Cleveland, to interests represented by the Second National Bank, Bucyus.

It is reported that efforts are being made by Kansas City, Mo., interests, to secure the transfer of the plant of the Standard Electric Stove Co., from Toledo, O., to Kansas City.

It recently was announced that the International Harvester Co., Chicago, recently purchased the plant of the Chattanooga Plow Co., Chattanooga, Tenn. Transfer of the property took effect June 1.

Plans have been completed for the erection of a plant to include a foundry, 100 x 430 feet, for the Keystone Iron Works, Merchants National Bank building, Los Angeles.

The Howlett Construction Co., Moline, Ill., manufacturer of locomotive coaling stations and devices, has been purchased by the Bay City Foundry Machine Co., Bay City, Mich.

Harry S. Way, Robert H. Smith and M. J. Levy recently were named as the incorporators of the Smith Foundry & Mfg. Co., Greenfield, Mass. The company is capitalized at $50,000.

A recent Iowa incorporation is that of the Foster Brass Foundries, Cedar Rapids, Iowa. The company is capitalized at $50,000 by W. H. Dutton, H. D. Foster and others.

The Holmes Electric Foundry Co. Worcester, Mass., is moving its plant from 19 Church street to a building in Foster Square. P. G. Holmes is head of the company.

The Owosso Bronze Bearing Co., Owosso, Mich., organized last February, recently increased its capital from $25,000 to $50,000 and is reported planning to erect a plant.

The Quincy Casting Co., Cedar Rapids, Iowa, recently let a contract to Theodore Stark & Co., to erect a foundry, 111 x 152 feet. Architect W. J. Brown, 313 American Trust building, Cedar Rapids, drew the plans for the building.

Property on which it plans to erect several buildings to be devoted to the manufacture of plumbers' supplies recently was purchased by the National Foundry Co., 32 Sanford street, New York.

Bids closed June 2 on the construction of a 1-story, brick, pattern and chipping shop for Lutz & Co., Inc., Camden, N. J. Charles E. Oelschlager is architect.

The secretary of the state of Indiana recently authorized the Muncie Foundry & Machine Co., Muncie, Ind., to increase its capital from $100,000 to $225,000.

Construction of an addition to the foundry of the American Seeding Machine Co., Springfield, O., recently was started by the Concrete Steel Construction Co.

Among the recent incorporations is that of the Star Foundry Co., Newark, N. J. The company, which is capitalized at $100,000, was incorporated by M. D. Patterson, J. J. Palitta and others.

Plans are being prepared by H. W. Bruemming for the erection of an addition, 50 x 100 feet, to the plant of the Sivyer Steel Casting Co., Milwaukee.

The foundry to be established by Levering Bros., Baltimore, in a building built at Buffalo for the Pierce Arrow Motor Co., which it recently purchased, will be utilized for the manufacture of sash weights.

The Cedar Falls Brass Foundry, Cedar Falls, Iowa, owned by Foster Bros., Waterloo, Iowa, recently was damaged by fire. They estimated the loss at $18,000, the pattern shop suffering the heaviest.

Nelson & Co., Robinson building, Racine, Wis., has the general contract to erect a foundry addition, 60 x 75 feet, to the plant of the Standard Foundry Co., Racine, Wis. E. R. Funston & Co. are architects.

Work is expected to be started shortly on the erection of a foundry addition, 80 x 160 feet, for the Duff Mfg. Co., Pittsburgh, of which E. A. Ginley is president. The Austin Co., Cleveland, has the general contract for the work.

A foundry and machine shop will be erected on Ford's Prairie, where a site was recently purchased by the Kane Pneumatic Shock Absorber Co., Centralia, Wash., according to a recent announcement by W. P. Kane, president of the company.

A charter has been issued to the Williamsport Foundry & Machine Works, Williamsport, Pa. The company is capitalized at $25,000. The incorporators are Hiram Heller, C. LeRoy Foulk and Calvin H. McCauley Jr.

The Advance Pump & Compressor Co., Battle Creek, Mich., is erecting a two-story machine shop, 60 x 125 feet, a foundry, 75 x 100 feet and a power house, 30 x 30 feet. Purchase of additional machinery is being contemplated.

C. V. S. Paul, vice president of the Hub Electric Steel Casting Co., Boston, states the company is erecting a plant, 65 x 150 feet, with modern foundry equipment, including a 2-ton electric furnace. It is expected the foundry will be ready for occupancy about Aug. 1.

Plans are being drawn by Architect S. N. Crowen, 30 North La Salle street, Chicago, for the erection of a foundry and office building for the American Truck Co., Chicago. The building will be 80 x 600 feet, and will be erected at 2952 West Chicago avenue.

The Aluminum Goods Mfg. Co., Manitowoc, Wis., has taken over the foundry and machine shop of the Aluminum Castings Co., Cleveland, which on May 1 discontinued its Manitowoc works and moved the equipment to the Detroit and Cleveland plants. The Aluminum Goods Mfg. Co. will raze the buildings and erect a large addition to its own plant.

Plans are being prepared for the erection of a machine shop, 1-story, 80 x 380 feet and a foundry, 60 x 240 feet, for the E. W. Bliss Co., Adams and Plymouth streets, Brooklyn, N. Y. The new buildings will be devoted to the manufacture of presses, auto parts, etc. Three 50-ton and three 30-ton electric traveling cranes will be installed and two 84-inch cupolas.

George R. Prout, president of the James Leffel Co., Springfield, O., stove manufacturer, recently announced the company had purchased the property and plant of the Columbia Planter Co., which will be converted into a new plant. Plans are now being drawn and construction is expected to start shortly. The new plant is expected to be ready for occupancy about Dec. 1.

At a recent meeting of the Alliance, O., Chamber of Commerce, it became known that Alliance and Cleveland interests are planning to erect a large steel casting plant at Alliance, providing they can obtain $20,000 from the city with which to provide a suitable site. W. H. Ramsey, president of the chamber of commerce, has the details of the project. The names of those interested have not been made public.

Erection of a foundry, 50 x 130 feet, is contemplated by the San Antonio Machine & Supply Co., San Antonio, Tex. The company plans to install two cupolas and a 10-ton electric traveling crane. Sand blast equipment, etc., will be purchased. In connection with the steel foundry the company will operate a brass foundry. A pattern storage house will also be erected. A feature of the plant will be an industrial railway which will travel throughout the entire plant.

New Trade Publications

FOUNDRY EQUIPMENT.—A bulletin devoted to the description and operation of modern foundry appliances recently was published by the Arcade Mfg. Co., Freeport, Ill. Among the machines described are squeezers; jolt-strip machines; molding machines; jolt stripping plate machines; pouring devices; core jolters and snap flasks. An illustration accompanies each description.

WELDING.—An interesting 4-page folder in which the operations involved in making a weld on a 13½-ton broken upper jaw of an alligator shear are described and illustrated, is being distributed by the Metal & Thermit Corp., New York. According to the folder the break welded was 80 inches in length and varied from 4½ to 23 inches in thickness. The shear was used by the Joseph Joseph & Bros. Co., Modena, Pa. The illustrations show the shear at various stages of the repair work.

SPECIAL STEEL.—A booklet of 24 pages has been issued by the Simonds Mfg. Co., Lockport, N. Y., which gives details and specifications of the crucible and electric furnace steels. The booklet contains a number of illustrations including that of a naval gun car, which the booklet states is armor plated with steel made by the Simonds Co. The steels manufactured by the company include light armor plate; carbon steel; cutlery steel; hack saw steel; high-speed steel; magnet steel and saw steel. The latter part of the booklet contains tables of decimals, gages and weights.

FOUNDRY LADLES.—The J. W. Paxson Co., Philadelphia, recently issued bulletin 34, in which it illustrates and describes the various ladles and pouring equipment which it manufactures. The ladles are constructed of heavy steel plates which are machine riveted to flanged steel heads. Trunnions are of steel, turned and fitted to large journals which are bolted to the bails with forged clamps. Standard gearing on stock ladles is of the worm and worm wheel type reduced through bevel gears to a hand wheel. Various data pertaining to the company's products are given and the booklet is profusely illustrated.

ALLOY STEELS.—Catalog No. 8 issued by the Carpenter Steel Co., Reading, Pa., describes chrome-nickel steels; steel for case-hardening; air-hardening steel; nickel steels; chrome steels; tungsten steel; chrome-vanadium steel and silicomanganese steels. The descriptions are thorough and are augmented by a number of illustrations and tables. Diagrams accompany several of the descriptions showing the physical properties in relation to drawing temperatures and the location of critical points upon the heating and cooling curves. One chapter of the booklet is devoted to these diagrams and chapters are given on hardness and impact tests and the pyrometer. A number of valuable tables, including conversion table; Fahrenheit and Centigrade scales; metric measure equivalents; mensuration tables; weights of bar steel, etc., are also given.